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## CONTENTS:


| | PAGE |
|---|---|
| Thermo-Electric Interpolation Formulæ ... ... ... ... | 223 |
| A Problem in Electro-Dynamics (*illustrated*) ... ... ... | 225 |
| Nikola Tesla at Niagara Falls ... ... ... ... ... | 225 |
| Effect of Temperature on Insulating Material (*illustrated*) ... | 226 |
| Contact Resistance ... ... ... ... ... ... ... | 227 |
| Graphic Representation of the Flux in the "Entrefer" of Dynamos (*illustrated*) ... ... ... ... ... ... | 228 |
| A Lesson from the Past ... ... ... ... ... ... | 228 |
| Li Chung Tang at Greenwich ... ... ... ... ... | 229 |
| Some Uses of Electricity in Metallurgy (*illustrated*) ... ... | 232 |
| The Glasgow Corporation Tramway Report ... ... ... | 232 |
| Traction Diagrams (*illustrated*) ... ... ... ... ... | 233 |
| Electric Repulsion ... ... ... ... ... ... ... | 235 |
| Correspondence:— | |
| Alternate Current Rushes in Condensers (*illustrated*) ... | 235 |
| York Electric Lighting... ... ... ... ... ... | 235 |
| High Voltage Lamps ... ... ... ... ... ... | 236 |
| Business Notices, &c.... ... ... .. ... ... ... | 236 |
| Electrical Factories and their Machinery.—II. (*illustrated*) ... | 237 |
| The Cable Ship "Tutaneki" (*illustrated*).. ... ... ... | 238 |
| The Cox Thermo-Electric Generator (*illustrated*) ... ... | 240 |
| Electric Lighting Notes ... ... ... ... ... ... | 242 |
| Electric Traction and Motive Power Notes ... ... ... | 243 |
| Telegraph and Telephone Notes ... ... ... ... ... | 244 |
| Contracts Open and Closed ... ... ... ... ... ... | 245 |
| Notes ... ... ... ... ... ... ... ... ... ... | 245 |
| City Notes ... ... ... ... ... ... ... ... ... | 248 |
| Traffic Receipts ... ... ... ... ... ... ... ... | 248 |
| Share List of Electrical Companies ... ... ... ... | 249 |
| A Criticism of the Science and Art Examination ... .. | 250 |
| Steam Piping for Power Plants ... ... ... ... ... | 251 |
| Electric and Magnetic Research at Low Temperatures (*illustrated*) (*continued*) ... ... ... ... ... ... | 251 |
| Electrical News from Australia ... ... ... ... ... | 253 |
| New Patents ... ... ... ... ... ... ... ... | 254 |
| Abstracts of Published Specifications ... ... ... ... | 254 |


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## THERMO-ELECTRIC INTERPOLATION FORMULÆ.

IN a paper presented to the American Academy of Arts and Sciences by Silas W. Holman, and reproduced in *Technology Quarterly*, pages 353 to 377, there is an important mathematical discussion of the applicability of interpolation formulæ. The several well-known types of formulæ, expressing thermal electromotive force of a couple as a function of the temperature of its junctions, are collected and examined. Two new formulæ are also proposed. All are then tested against the most reliable experimental data which have been accumulated upon this subject, and their relative merits are discussed, the main object being to bring pyrometry into the position of a more exact science. The experimental date of Barus, Holborn and Wien, Chassagny and Abraham and Noll, were chosen for testing these formulæ, because all these investigators have employed modern methods of thermometry and of electrical measurements.

It is quite impossible, in a short abstract of this paper, to follow the author through the mathematical analysis which he employs; for this our readers must consult the original paper. The results, however, of this investigation may be briefly noticed.

The general conclusion as to applicability seems to be that, while the *Avenarius* expression may be equally good, or better than the exponential for interpolation over short ranges, yet for interpolation over long ranges, and for extrapolation above the observation limits, the exponential is decidedly preferable.

The logarithmic form, although closely applicable to the Barus data, is of more doubtful general value; yet on account of its great convenience, it may find application in industrial pyrometry. Although failing below 300° or 400°, it may probably be applied to the irido- or rhodo-platinum couple between 400° and 1,200° C., with a maximum error not exceeding about 5°. If extended to cover 400° to 2,000°, the error might rise to 15° or 20°.

More in detail, it may be briefly noted by way of summary:

That the logarithmic equation fits the Barus data between 400° and 1,250°, with scarcely sensible systematic error, and within the limits of variable errors of the data.

That the exponental equation similarly fits the Holborn and Wien data within the limits of 400° to 1,445°.

That when made to coincide with the data at about 450° and 1,200°, the systematic deviations of the exponential equation from the Barus data, and of the logarithmic equation from the Holborn and Wien date, are in general of opposite sign, and of roughly equal magnitude.

Review of the laborious researches which have been devoted to the direct comparison of thermo-electric elements with the air thermometer, mainly for the purpose of advancing the art of pyrometry, has enforced the conviction that, at least for the immediate future, this end would be better served by accurate gas thermometer measurements of melting points of metals. Each such determination made upon a reproducible metal of known high purity under proper reproducible conditions, fixes an enduring and reproducible reference point, a pyrometric "bench mark." And there are enough inexpensive metals, together with a possible system of simple alloys, to give points of sufficient frequency. These would then afford a convenient means of obtaining accurately known high temperatures for purposes of study of all high temperature phenomena, and particularly for calibrating thermo-electric, electrical resistance, optical, or other secondary pyrometric interpolation apparatus, for it must be remembered that all such apparatus is necessarily secondary, the gas thermometer being inevitably the primary.

On the other hand, comparison with the air thermometer of a thermo-couple or of a resistance pyrometer, or the study of any progressive thermal phenomenon, while it possibly may result in the eduction of a natural law, is very unlikely to lead to anything more than the establishment of an approximate equation, with constants characteristic only of the individual materials actually employed, and not transferable to other, although similar materials. Such results are obviously of a much more ephemeral character than the melting point measurements. Even when any pyrometric apparatus thus tested is applied to the establishment of melting points, it must, at best, yield results inferior to the direct application of the gas thermometer, except in cases where the latter is hampered by want of sufficient quantity of the metal to be experimented upon, a condition which need only affect such costly substances as gold and platinum.

Stated broadly, the great need of the art of pyrometry is convenient methods of producing, or of recognising when produced, a series of accurately known high temperatures. The analagous problem has been partially solved for thermometry at temperatures up to 300° C., by the investigation of boiling points of certain chemically pure substances under controlled pressure.

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The Tramways Institute.

THE meeting and annual dinner of this Institute recently held, gave rise to a good many thoughts and not a few regrets. What a pity it is for instance (as a prominent man in traction affairs expressed himself to us the other day) that the Institute does not rise to its opportunities! With all the advantages of having been established for some time, and of a considerable membership, the meetings and discussions are absolutely void of all practical interest for go-ahead progressive tramway men. At least half the members seem pledged to horse traction, while the rest seem to favour the use of steam engines above everything. Of course this is perhaps no more than can be expected; they know little or nothing of cable or electric working and mistrust them both. A Tramways Institute to-day has got to be a live society, not an assemblage of "Old Buffers" who have doubtless done efficient work in time past, but need new blood and fresh energies to deal vigorously with modern problems of rapid transit. No greater contrast can be imagined than that between the proceedings of this Institute, and of the lately formed Municipal Electrical Association, where virile experience reigned throughout. As for the topics brought before and discussed by the Tramways Institute the less said the better; one is tempted to characterise them as absolute rubbish, dealing chiefly with combined car brakes and starters in endless variety—all equally ingenious and futile—some of the more complicated mechanical traction systems which are not thought worthy of description by the technical press, together with violently prejudiced attacks on this or that system faintly disguised by advocacy of its rival. Who, for instance—touching upon the subjects and papers dealt with last week—would for a moment take Mr. John Sturgeon seriously? Even the most enthusiastic electric traction advocate will admit the scope of cable lines, but Mr. Sturgeon can see no good in anything electric—*except on country lines, say, on a 15-minute headway!* Mr. Sturgeon is doubtless a big fish, but he mustn't consider himself a whale on electric traction when he talks like that. We cannot help thinking it more than time that the leading spirits in electric and cable traction ought either to join the Tramways Institute in a body, and take immediate steps to raise its discussions and membership to a position of high value, or else to form a new and living society, leaving the older one to confine its attention to horse traction, compressed air, and steam systems, gradually dying out itself as its subjects of discussion and interest also diminish in importance and numbers.

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The Mistakes Arising from Slow Speed.

THAT the prevailing tendency to reduce the speed of electrical machinery is a mistake is the opinion of Mr. Baxter, who writes to this effect in the *Electrical World*. He says that experience has proved high speeds not to be productive of destructive or rapid wear, for there are high speed dynamos of 15 years of age in use to day little the worse for wear, and with the original bushings of solid bearings still in use. He thinks direct connection good enough for 200 kilowatts and upwards, but wrong for smaller sizes, the only advantage being compactness. Belted generators are all that can be desired on the score of durability. They can be made to show only 2 per cent. for repairs, including belt renewals, per year, and the direct connected machine can hardly improve on this. He thinks also that the wear and tear arising from change of load is specially severe on direct connected machines. On railway work especially they are apt to be short circuited. Belts absorb the shock which is so severe on a direct connected unit, and moreover, to secure direct connection, efficiency is sacrificed in order to keep the constructive cost low. A belted machine may run at any speed up to a belt speed of 4,000 to 6,000 feet per minute for units of 20 or 25 to 75 or 100 kw. With these speeds belts may be kept narrow. Motors also have been affected by the striving for slow speeds. Yet a motor can usually be belted directly to a line shaft by running it at 1,200 to 1,400 revolutions. A 4-inch pulley and a 1-inch belt will drive a 16-inch pulley at 350 turns and convey 1 H.P., the belt speed being 1,500 per minute, while the stress on a 2-inch belt would be very slight. Even a 10 horse-power motor at 1,000 revolutions could be directly belted to line shaft at 200 by a 5 to 1 pulley ratio, say 8 inches and 40 inches, with a 4 or 5-inch belt at 2,000 feet velocity. He advises always belting direct to the line shaft and using the highest motor speed possible with convenient pulleys. It would certainly appear sound mechanical practice with revolving shafts and other pieces capable of being exactly balanced, to run them at high speeds and so save weights and costs. A great aid to high speed and durability is to use ample bearings.

## A PROBLEM IN ELECTRO-DYNAMICS.

[COMMUNICATED.]

A CORRESPONDENT in *Electricity*, of New York, puts a problem forward for solution as follows :—

"In the accompanying cut (fig. 1), N S, to the left is a bipolar stationary field. A is a revolving Gramme ring with the two coils wound upon it connected up in series. Keyed to the same shaft is a laminated soft iron bar wound with coils whose terminals are connected with the terminals of the Gramme ring A. This bar magnet, N S, revolves in the centre of a *stationary* Gramme ring B, whose coils are connected as shown, to the coils of the stationary field N S.

"As the coils, A, revolve, they will, of course, generate an alternating current which will have its maxima when the coils are in the position shown, and its minima when the coils are 90 degrees from this position. This current excites the bar magnet, B, and of course reverses its polarity with each reversal of the current. But as this bar magnet also revolves with the coils, A, we always have lines of the same sign cutting the coils on the stationary ring, C D.

"Thus if the coils are so connected that when the bar is in a vertical position, as shown, the upper end is of north and the lower of south polarity; when it has revolved through 90 degrees there will be no magnetism, because the coils A are then cutting no lines of force. As it passes 90 degrees and until it has reached 180 degrees, what was before a decreasing north pole will be an increasing south pole, and thus the upper half of the ring C will always be cut by positive lines of force and the lower half by negative lines of force, and the current generated will be a pulsatory one, but without change of direction.

"Of course, if we place two more coils on the revolving ring at right angles to those represented, and connect them to suitably arranged coils on another bar magnet at right angles to B, then when the first set are in a minimum position the second will be in a maximum position, and so by multiplication of elements a practically steady direct current would be obtained without the use of commutators."

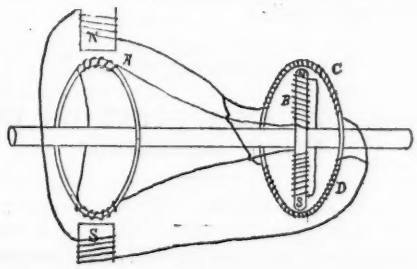



FIG. 1.

Theoretically a pulsatory current would be produced in the armature, but whether a machine of this type would ever excite itself is very doubtful.

The difficulties begin when attempts are made to make the current approximately continuous by multipolar arrangements.

A machine designed on the same principles by Rankin Kennedy and described in Patent No. 18,491 of 1890 for alternating currents is shown diagrammatically in fig. 2 and 3. In this machine the exciter is a permanent magneto machine with a ring armature; each section on the armature excites a single pole on the alternator field as shown in figure 3, where a coil is shown on the ring to correspond to a pole on the internal revolving field magnet.

The line R K, is the line upon which commutation would take place if there was a commutator on the exciter. Any given pole moving from R to K, and from K to R, maintains the same polarity during nearly one-half revolution.

In this machine there is absolutely no commutator, no bushes, no slip rings, but that is in consequence of using permanent magnets for exciting.

It is obvious that in this machine the poles could be expanded near to the winding, and all the poles on one side of line R K, could be made of same polarity, and in that case the coils on the ring armature would be continually cut by lines of same sign exactly as in fig. 1.

That cutting of lines of force by a conductor sets up E.M.F., is, however, only a convenient fiction of theory, and not an absolute fact, is generally proved when we come to push its application too far as in this case.

Tested by the other theory, the rate of increasing and decreasing the flux through the coils, setting up the E.M.F., it is obvious that the number of lines enclosed by any given turn of wire on the armature would be practically constant, for although the field revolves bodily its poles are fixed in space, by the very device which is employed in the proposal, fig. 1, for the purpose of continually cutting the conductors by lines of same polarity.

All these so called problems are best tested by this flux density question, if the flux through the coils is constant and not rising or falling there is no E.M.F.

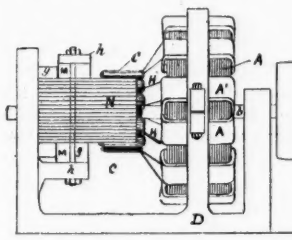



FIG. 2.

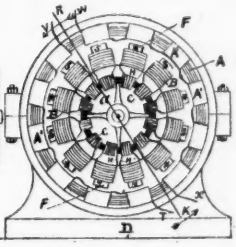



FIG. 3.

In fig. 1, with small field poles and permanent exciting magnets, the only effect would be an alternating E.M.F., and the best effect would be got by placing the magnet B inside the ring at right angles to the position shown in fig. 1, and the E.M.F. would be due to the rise and fall of induction of same lines through the coil, same as in a Mordey alternator.

In Kennedy's machine this can be done also, but in the patent it is shown with alternating N and S poles, so that the flux not only rises and falls, but also reverses.

This machine was proposed for lighthouse illumination to take the place of magnetos, being quite as simple and much smaller for the output.

In fig. 2, N are permanent horse-shoe magnets, C the Gramme ring, H H connections to field magnet, A, alternator armature.

## NIKOLA TESLA AT NIAGARA FALLS.

Mr. ORRIN E. DUNLAP, in the *Western Electrician*, says that Nikola Tesla paid his first visit to the great electrical power plant of the Niagara Falls Power Company on Sunday, July 19th. In the party with Tesla were George Westinghouse, jun., president of the Westinghouse Electric and Manufacturing Company, of Pittsburg, and his son, H. H. Westinghouse; Thomas N. Ely, of Philadelphia, superintendent of motive power of the Pennsylvania Railroad; Commodore George W. Melville, of Washington, chief engineer of the United States Navy; Edward D. Adams, president of the Cataract Construction Company, and William B. Rankine, secretary of the company; Paul D. Cravath, counsel for the Westinghouse Company; and George Urban, jun., of Buffalo, president of the Cataract Power and Construction Company, of Buffalo, which company was organised recently to distribute the electric power in Buffalo.

Quite naturally, the event of Tesla's visit was one of importance, for never before had his eyes rested on this greatest of power plants. For four years he had refused to leave his work and visit the Falls, preferring to work out his theories and await the proper time to see them put into practical use and operation. Tesla was delighted with the manner in which his discoveries had been adapted to practical use by the engineers, and he unhesitatingly declared that there was no doubt of the success of the gigantic undertaking, and that power would be transmitted to Buffalo without the least semblance of failure in any important detail. He was greatly interested in the working of the transformers invented by

him, and the great electrician declared that they solved one of the most difficult and important problems in electrical science.

It is a well known fact that Tesla does not like to speak of himself. He will talk freely about electrical discoveries or inventions, but when his own are broached he modestly says that he prefers to say little about them.

"I do not like to speak of what I am doing or what I hope to do," said he. "It is enough to let others do that when what I have done is before the world. I am content to be in my workshop and to work day and night to discover something which we are looking for, and which will assist the development of electricity as a great and universal power. The time will come when steam will not be used for commercial purposes. I am working to bring that about." This, then, is the present great ambition. He desires to see electricity fully occupy the power field.

"I came to Niagara Falls," said he, "to inspect the great power plant, and because I thought the change would bring me needed rest. I have been for some time in poor health, almost worn out, and I am now trying to get away from my work for a brief spell, and at the same time see the great results of electrical development within the last half dozen years. Those results have been wonderful, have far surpassed the expectations of the people generally, but they are what those who have made electricity their study for years and their life work have expected, and have laboured so hard to bring about. Yet scientists are not content, and great wonders in the future development of electric power for many purposes are anticipated, and are confidently expected, by the great men in all countries who are trying to discover Nature's secrets, and to develop the things which God has placed within the reach of those who will seek that they may find."

"What do you think of the Niagara power plant, Mr. Tesla? Is it fully up to your ideas and expectations?"

It was this question that aroused the great electrician's enthusiasm. "Yes," said he; "it is all and more than I anticipated it would be. It is fully all that was promised. It is one of the wonders of this century. The power-producing plant of the Cataract Construction Company is a marvel in its completeness and in its superiority of construction. When it shall be in full operation the results, in many ways, will be wonderful; will be surprising to those who have doubted that such things could be accomplished. In its entirety, in connection with the possibilities of the future, the plant, and the prospect of future development in electrical science, and the more ordinary uses of electricity, are my ideals. They are what I have long anticipated, and have laboured, in an insignificant way, to contribute toward bringing about."

"What, in your judgment, will be the effect on Niagara Falls?"

"The first effects naturally will be to the advantage of Niagara Falls, and the falls will be the greatest reaper of benefits. The result of this great development of electric power will be that the Falls and Buffalo will reach out their arms, and will join each other, and become one great city. United, they will form the greatest city in the world."

"This is your first visit to the plant?"

"Yes; I came purposely to see it. I am somewhat interested in the working of some of the machinery. But, and it is a curious thing about me, I cannot stay about big machinery a great while. It affects me very much. The jar of the machinery curiously affects my spine, and I cannot stand the strain."

"It is Mr. Tesla's two-phase system which is used," put in Secretary Rankine, who was standing by. "It is the new and great system of the two-phase alternating currents."

"What do you think of the transmission of electric power to Buffalo? Is it an assured undertaking?" Tesla was asked.

"Its success is certain. The transmission of electricity is one of the simplest of propositions. It is but the application of pronounced and accepted rules which are as firmly established as the air itself."

"Do you think the cost of electric power in Buffalo will be half, or lower than the present cost of steam?"

"I do not know what is the cost of steam power in Buffalo."

"About $60 to $70," said Mr. Rankine.

"Well," continued Mr. Tesla, "the cost certainly will be much less than the cost of steam. The beauty of using electricity for industrial purposes is that you can use it without any loss. When you get done with your work, you just shut it off until you want it again; therefore there is no appreciable percentage of loss, except that in transmission. On the other hand, you cannot use steam without loss. Steam must be kept up. That involves a loss of 20 per cent. at the start, which is continuous, and must be counted as a fixed loss. No matter if steam were cheaper than electricity, there would be a great saving in favour of electricity, because of its adaptability, its freedom from smoke and dust, and the fact that it may be shut off when it is not needed."

At this point Secretary Rankine advanced a piece of news. "Buffalo," said he, "will have its first instalment of electric power by November. You may say that without fear of making any mistake. The first delivery will be about 1,000 horse power, all that we can give this fall. It will be the initial instalment of the 10,000 horse power which we must furnish under our franchise within the ensuing year. The contract for the construction of the pole line will soon be let. The work will be pushed rapidly, and Buffalo will find that the company will be faithful to all of its agreements."

In regard to the transmission of power, Tesla continued: "It is cheaper to transmit electricity in large quantities than in small. The larger the force the less the loss in transmission. The loss in transmission of power to Buffalo, for instance, will be comparatively small because of the large quantity which Buffalo will receive."

Tesla was averse to speaking of his recent investigations of the vacuum electric lamp and telegraphy without the use of wires.

"I am not prepared to say anything now about those little schemes of mine," said Mr. Tesla. "They must stand aside for awhile. Just now I am devoting my time to the study and development of the transmission and insulation of electricity. Until I get these matters well worked out, and obtain satisfactory results, I shall do little else. I shall return to my laboratory in New York and continue my work. I am delighted with my trip to the Falls. I have been from top to bottom of the power plant. You may say it is the greatest and the best, the most thoroughly equipped in the world."

## EFFECT OF TEMPERATURE ON INSULATING MATERIAL.*

By CHAS. F. SCOTT.

In the discussion of the paper on "Effect of Temperature on Insulating Materials," I referred to certain tests made by Mr. C. E. Skinner. Mr. Skinner has kindly furnished the following statement of some results which he has obtained in his work in this line:—

"Some time ago a series of tests were undertaken to determine the effect of temperature on the insulation resistance and breaking down E.M.F. of various insulating materials, and of completed apparatus. A large number of insulating materials, including paper, cloth, &c., both in the treated and untreated forms, were tested. The tests on completed apparatus were made on armatures, fields, converters, &c., these pieces of apparatus being treated in various ways before the tests were made.

"1. *Tests on Insulating Materials.*—Various methods of making these tests were tried. The apparatus illustrated in fig. 1 was finally adopted for standard tests as being best suited for practical work. This piece of apparatus consists of two similar parts, the two parts forming the plates between which the insulating material is placed when tested. These plates are 10 inches in diameter, and are carefully surfaced. Each part is made of two separate pieces of cast-iron, fastened together as shown, and wound with a coil of asbestos-covered wire. The heating of the apparatus is effected by sending an alternating current through the two coils in series. The heating results from the eddy current and hysteresis loss

* Communicated after adjournment of the annual meeting of the American Institute of Electrical Engineers.

in the iron as well as from the copper loss in the coil. The rate of heating can be controlled easily by means of a suitable rheostat in circuit with the coils, the mass of iron in the heater being sufficient to prevent sudden changes of temperature from outside causes. The insulation resistance of the samples was measured in all cases by means of a high resistance voltmeter on a 500-volt circuit, all wires of the heating circuit being disconnected when the insulation measurements were made. This method of measurement was adopted on account of the portability of the apparatus and the facility with which the measurements could be made, a complete measurement of insulation resistance requiring from 10 to 15 seconds. Ordinarily the time occupied in making a complete test on a sample of material was from one to two hours. Insulation resistance readings were made at frequent intervals.

"It was found that the minimum resistance is reached at slightly below 100° C. From this point the resistance rises rapidly until it reaches a point too high to be measured with the apparatus used. The absolute value of the insulation resistance of any material of this class depends on the amount of moisture in the material at the start, the rate of heating, and the chance for the escape of moisture during the test. The temperature at which the insulation resistance is lowest depends slightly on the rate of heating. A curve showing the plotted out results indicated that the results are characteristic of all materials of a fibrous nature which do not

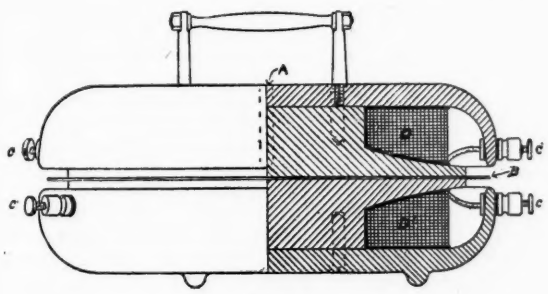


Fig. 1.

contain chemicals or materials which are readily changed by heat. The absolute values of the insulation resistance for different materials, or even for two samples of the same material, are rarely the same; but the general shape of the curve has been found to be practically the same for all such materials, the tests extending over a period of several years, and being made in many ways.

"As regards oiled paper, the absolute value of the insulation resistance depends largely on the drying of the material before treatment. Samples of cloth which were treated with linseed oil, after being thoroughly dried, and the oil baked on, do not at any time show a very low insulation resistance, even at a temperature of 150° C.

"·015" calendered press-board, made of a mixture of scrap paper and rags, gave results as follows:—The temperature was gradually raised to 120° C., the time occupied in reaching this temperature being 30 minutes. The temperature was maintained constant at 120° for 31 hours. At the end of this time the temperature was increased to 280°. At the end of 30 minutes the insulation resistance had fallen from 85 megohms to less than 1 megohm, and again risen to about 12 megohms. The lowest point reached was ·032 megohms. At the end of 70 minutes the insulation resistance had become too great to be measured by the apparatus at hand. Frequent readings were taken during the 31 hours' run at 120° C., but at no time was it possible to measure the insulation resistance. When the temperature was again raised at the end of 31 hours, the insulation resistance again fell. At 150° the first measurements could be made. At 195° the first smoke was noticed issuing from between the plates. At 220° C. smoke was issuing in volumes from all sides of the piece under test. At 280° the sample was charred to such an extent that the edges extending beyond the heating plates were broken off. At this point the test was unavoidably stopped. Sixty hours later, the sample not being disturbed in any way, it was found that the insulation resistance was above 100 megohms.

"2. *Tests on Completed Apparatus.*—These were tests on a motor armature which was wound without previous drying of any of its insulating materials. The motor was run with an overload, and measurements were made at frequent intervals. The temperature could not be taken until the end of the run, when it was found to be about 110° C. The lowest insulation resistance reached in this test was 4,500 ohms. At the end of 70 hours the insulation resistance on the armature had become so high that insulation resistance measurements could not be made. After standing for 17 days the test was repeated. The general shape of the curve for the second test was the same as for the first, but the insulation resistance did not drop so rapidly nor so low, the lowest point reached being 500,000 ohms. Insulation resistance measurements made on the fields at the same time show that the resistance of this part did not drop so rapidly, but remained low for a longer time. This is explained by the fact that there is a greater amount of wire in the field coils and not so good a chance for the escape of moisture. The curve obtained is characteristic of all apparatus tested. The lowest values reached, however, for different apparatus, vary greatly with the character of the apparatus and the previous treatment. Motors which were wound with materials which had been treated, then dried, and the motors again dried after being wound, show the best results.

"3. *Relation Between Breaking-Down E.M.F. and Insulation Resistance.*—An attempt was made to establish the relation between the breaking-down test of insulating materials and their insulation resistance. For this purpose samples of paper, which gave a very uniform breaking-down test in the normal state, were heated up until the insulation resistance reached a certain predetermined amount, when the breaking-down test was quickly made. It was found impossible to establish any definite relation between the two, even for a given material. It was found, however, that a low insulation resistance usually meant a low breaking-down test, but a low breaking-down test did not necessarily mean a low insulation resistance. These two tests may be compared to the chemical analysis and the tensile test of iron. A poor chemical analysis means poor physical qualities, but a good chemical analysis does not indicate whether or not there are flaws in the metal.

"4. *Conclusions.*

"(*a*) The insulation resistance of all ordinary fibrous insulating materials, such as paper, cloth, &c., decreases upon being heated up, and then increases again when the moisture is expelled.

"(*b*) Continued heating of 31 hours at 120° C. does not lower the insulation resistance of paper.

"(*c*) The insulation resistance of completed apparatus shows the same characteristics as the insulation resistance of materials taken separately.

"(*d*) A low insulation resistance is not necessarily an indication of poor insulation, but probably an indication of the condition of the apparatus in regard to moisture.

"(*e*) A high E.M.F. should not be applied to apparatus when the insulation resistance is low.

"(*f*) Material which is badly deteriorated mechanically by heat may still have a high insulation resistance, but very poor insulating qualities."

## CONTACT RESISTANCE.

Mr. Charles Wirt, writing to the New York *Electrical Engineer*, referring to the results given under the heading, "Phenomena of Commutator Resistance" in our contemporary recently, thinks it worth while to direct attention to the great difference existing in the case of contact resistance between surfaces at rest and in motion. Contact resistance is an important subject on which very little information has been published. The article quoted asserts that in the case under consideration (contact between surfaces in motion), pressure has but a slight effect on the contact resistance.

The writer carried out a set of rather crude experiments relating to contact resistance between surfaces at rest in the Edison Laboratory a few years since. The apparatus consisted merely of a pair of circular contact blocks of red brass, 2 inches diameter by 1 inch thick, with means for

measuring the contact resistance and pressure. The potential difference at the contact was measured by a Kelvin galvanometer previously calibrated and connected from block to block, using measured currents of a few amperes sufficient to give a suitable deflection. The facts deduced were as follows:—

1. With pressures between 25 and 250 lbs. per square inch resistance varies nearly inversely as the pressure.

2. The total pressure remaining constant, reduction of area does not alter resistance within wide limits.

3. Pressure and area remaining constant, variations in the perfection of fit between the surfaces produces slight, if any, change in the resistance.

4. Clean petroleum oil placed between the contact surfaces does not greatly alter the resistance.

5. Clean petroleum oil mixed with pure graphite to the consistency of cream does not greatly alter the resistance.

6. A washer of thick tinfoil (pure tin) interposed between the contact surfaces gave a total resistance for the double contact not greater than the single contact of the blocks with each other, except with the lighter pressures.

No time tests were made. During the experiment, the two surfaces were fitted until the lower block could be lifted by the upper block by suction. Ordinary care was taken to exclude dust. The slight effect of oil on the resistance is surprising, as with well-fitted surfaces and only moderate pressure, it might be expected that a continuous film of oil would interpose between the plates. It would appear that actual contact between the surfaces with moderate pressure, even with well-fitted surfaces, is at a few points only that increase of pressure brings more points into contact in proportion to the pressure; also, that the actual points of contact are able to displace the liquid film.

A careful quantitative study of this subject would be of great interest and practical value. In all electrical connections not soldered, it should be remembered, as a useful rule of thumb, that conductivity depends within wide limits not on area of contact, but on pressure. This is at variance with practice, but is undoubtedly true.

Large surface of contact is of value, in switches, for instance, for giving increased radiating surface and proper conductivity without undue pressure per unit of surface area; that is to say, in switches, while conductivity might be secured with less surface than is now the usual practice, under sliding motion such pressure would give increased tendency to cut. In bus-bar joints, and similar cases of joints carrying large currents, where the conductors are ample, if a heavy pressure can be secured and maintained, the area of contact may safely be reduced to the amount required by mechanical considerations. It is also probably true that in such joints the interposition of a washer of pure tin, not too thick, is of advantage in protecting joints from the effects of corrosion.

## GRAPHIC REPRESENTATION OF THE FLUX IN THE "ENTREFER" OF DYNAMOS.

The following is an interesting method of representing the flux in dynamos. It might be of considerable service in the examination of the machines by showing the internal causes of variations of voltage.

We do not determine the exact value of the flux in the "entrefer," but a series of values on a given scale, and at different points, so as to be able to compare them. Curves are then traced in polar co-ordinates. The employment of the ballistic galvanometer with the test bobbin is shown. We can, in fact, procure flat bobbins so reduced in size that it is possible to introduce them between the pole pieces and the armature. Fig. 1 shows the form of the flux obtained when running without a load. The flux is at its maximum at I, following the line of the poles, and at its minimum in the neutral plane. The induction is represented proportionately by the values of I, intercepted on the rays of the polar apertures and the inner curve. We see that the flux is to all intents constant when the extent is large, without load, be it understood. It is quite another thing when we are working at full load (fig. 2). The flux in the "entrefer" is then the resultant of the fluxes developed by the field magnet and the armature, taking into account the demagnetisation due to the position of the brushes when the sparks are at a minimum.

The flux diminishes on the line of the poles; it is greater than when running without load, at I′ near the polar gaps

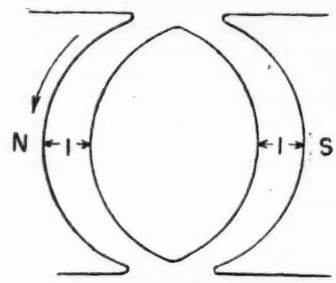



Fig. 1.

which are then saturated. If, besides the representation of the flux, we add that of the actual position of the brushes, we can easily see how the voltage would be varied by loosening them a little. It would be increased by placing them behind the direction of rotation, and diminished by making them take the contrary position.

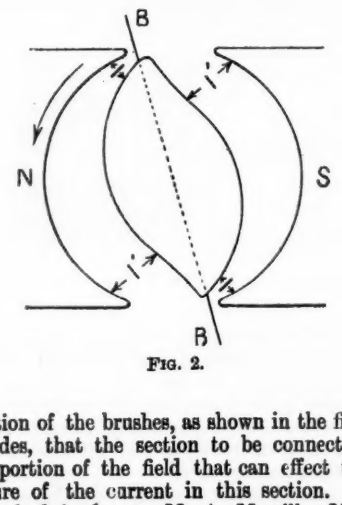



Fig. 2.

The position of the brushes, as shown in the figure, shows clearly, besides, that the section to be connected must be placed in a portion of the field that can effect the reversal of the nature of the current in this section. This very practical method is due to M. A. Merrill.—M. Aliamet (*L'Electricien*).

## A LESSON FROM THE PAST.

Patent litigation has been so virulent and disastrous during the last few years, that a strong feeling has grown up among manufacturers to rely on secret rather than on patented processes. Such a condition, says Mr. W. M. Stine, in the *Electrical World*, is naturally an unhealthy one, and especially so when it predominates manufactories whose very being is dependent upon the applications of scientific principles, and whose every advancement must come from them.

Thoughtful readers of the current and formal literature of applied and theoretical electricity are inevitably impressed by the lack of co-ordination which confronts them on nearly all lines of investigation. To be explicit, two cases may be singled out, the transformer and dynamo-electric machinery of the alternating current type, though the same may be said of about all types. How seldom in the discussion of such apparatus are dimensional and winding data given! Many of our better electrical manufacturing companies have accumulated vast stores of data and facts relating not only to the physical and magnetic character of iron and steel construction materials, but to a variety of interesting electromagnetic phenomena, which, if placed freely at the disposal

of those engaged along the more theoretical lines, would prove of incalculable benefit, not only in more thoroughly co-ordinating practice and theory, but in inspiring and directing greater advancement.

It is a question if the various branches of electrotechnics have not already reached that stage of development where competitive excellence of products rests on processes of manufacture rather than on the applied principles, and manufacturers, by their conservative attitude, are impeding their own financial and productive advancement.

The arguments upon which the manufacturing interests base their conservatism are by no means new, but are, in fact, of very ancient origin, as those familiar with the history of applied science well know. An interesting expression of these sentiments is found in an early number of the *Philosophical Magazine*, issued nearly a century back. It is to this effect:—

"It is much to be wished that men practically versed in the various manufactures of Britain would turn their attention to the best means of dissemination of knowledge of the principles and operations which have been determined, by experience, as the best to be followed in the large way, according to local and other circumstances. A candid and liberal communication of individual observation, by promoting the common interest, would tend ultimately to the benefit of each manufacturer, by the increased improvement of their various articles; for the real welfare of any particular branch depends less upon the superiority of any one man's article over that of another, in the same line, than upon the general superiority of a national product over that of any other country—a pre-eminence that depends entirely on the aggregate mass of industry, ingenuity and intellect exerted in the one or the other.

"What I recommend is the more necessary, as inaccurate and fallacious principles are often brought forward by men of science, even the best intentioned, from a want of that practical knowledge which can only be acquired by a long and personal acquaintance carried on in the large way of manufacture. The mischiefs hence occasioned are incredible; it tends to separate the men of science and the manufacturers; it shackles the latter with increasing prejudice; makes him view the former with a suspicious eye; it is the principal reason why science has been so long excluded from our manufactories, and why the accurate results of the laboratory have been so long despised by the practical artist, and been deemed undeserving of experiment on an extended scale. The artist and the man of science should mutually inform each other; principles will then, and not till then, acquire consistence and correctness, and their value will be established on the surest foundation."

## LI CHUNG TANG AT GREENWICH.

Early on Friday morning last, His Excellency Li Chung Tang left Charing Cross by special train for Greenwich, where, upon the invitation of the Eastern Extension, Great Northern, and Telegraph Construction and Maintenance Companies, he was entertained at the latter Company's cable works, Enderby's Wharf. He was accompanied by Admiral Tracey, Mr. Lo Feng-Luh, Mr. B. C. G. Scott, Mr. Yuh Sih-mei, and other gentlemen, and was received on his arrival by the Marquis of Tweeddale (chairman of the Eastern and Eastern Extension Telegraph Companies), Admiral Sir George H. Richards (chairman of the Telegraph Construction and Maintenance Company), Mr. J. Denison Pender and Sir Albert Cappel (directors of the Eastern Extension Telegraph Company), Sir Robert Herbert, Sir Anthony Hoskins, and Mr. Campbell (directors of the Telegraph Construction and Maintenance Company), Mr. William Shuter (managing director of the Telegraph Construction and Maintenance Company), Mr. Hesse (secretary and manager of the Eastern Extension Telegraph Company), Mr. Dickens (secretary to the Telegraph Construction and Maintenance Company), and Commodore Suenson (managing director of the Great Northern Telegraph Company). The preparations for the reception of Li Chung Tang were made on the most magnificent scale. In addition to a private suite of luxurious rooms for his Excellency's use, there was a magnificent marquee, canopied with yellow and white draperies, the walls being hung with tapestry, having a plush and gold valance, the entrances screened by Madras curtains, the serving tables hidden behind palms and girandoles, and the central poles trophied with Chinese flags and Royal standards and entwined with roses. Palms were also effectively employed in combination with Chinese lanterns. In this grand tent, laid with a ball-room floor, the tables for 140 guests were set, the tables themselves being most artistically and florally decorated, large bouquets of asters and roses here and there breaking the long line of white napery, gleaming silver, and most delicate glass.

For lavishness, brilliance, and exquisite taste, the *fête* was unsurpassable, and well might His Excellency desire to publicly express his thanks to his hosts, to whom we offer our heartiest congratulations on a success significant in more ways than one, for the enjoyment he had derived from his visit to Greenwich.

"He was specially struck," said Mr. Lo Feng-Luh, His Excellency's first secretary, "with the marquee, never before having seen such a large one. His Excellency thought it was beautifully arranged, and the sweet smell of the plants and the profuse display of flowers much pleased him. He has been in Russia, Germany, and France, but has never seen such a nicely decorated table."

For once, at all events, English and Eastern ideas of artistic effects were in cordial agreement, and the result was a perfect triumph of the caterer's art.

Mr. Shuter requested the ex-Viceroy to accept two cable curiosities, which were separately enclosed in glass tubes, with a small square of vulcanite at each end. The first was a piece of the experimental core laid in 1850 from Dover to Calais, which was recovered in 1875, having only worked for three days. The other souvenir was a piece of the 1858 Atlantic cable, picked up in August, 1880, by the *Scotia*.

Li Chung Tang, shortly after his arrival, was invited to take his seat at the table in the reception room, where two instruments were at work, the order to "clear the lines" to the Far East having been immediately given. A placard over each machine stated that it was connected with a wire serving as a means of communication between China and the cable works in three sections, thus:—England to Egypt, 3,921 miles; Egypt to India, 3,917; India to China, 4,770; total, 12,608 miles. The route actually followed was from Greenwich to Land's End, thence to Egypt, thence to Bombay, thence, *via* the India land line, to Madras, and afterwards by submarine cable to Shanghai. It may be noted that from Hong Kong to Shanghai the lines are worked jointly by the Eastern Extension Company and the Great Northern Telegraph Company. His Excellency was told that he might communicate with the extreme point of the system—Shanghai—as it was impossible to reach Pekin without the co-operation of the Chinese Internal Telegraph Administration.

Mr. John Denison Pender, managing director of the Eastern Telegraph Company, directed the operations, which were carried out under the superintendence of Mr. T. A. Bullock and Mr. H. A. C. Saunders (the electrician-in-chief). The following message was despatched at 10h. 29½ min. to the managers of the China Merchants' Steam Navigation Company, Shanghai:—

**Leaving England for America 22nd, thence for Canada 1st, eighth moon. Will leave Vancouver on 8th per *Empress of China*, expected to arrive Yokohama 22nd. Please despatch either Fushun or Kwang Li, under command of Captain Wallace, to wait for us there for conveyance to Tien-tsin. The famine funds for Ngan-hwei difficult to be collected. Where is Shen Suen Hwei? Reply immediately.—Li Chung Tang.**

In 2 minutes 30 seconds the announcement was read from Madras that the telegram had reached there, and in 12½ minutes after the telegram left Greenwich an acknowledgment was received from Shanghai. The actual reply, which was despatched from Shanghai a few minutes later, occupied 7 minutes in transmission to Greenwich, a truly wonderful performance when it is considered that the telegram was written partly in Chinese, that is to say, in 64 cipher groups, each representing a Chinese character. For this purpose use was made of the telegraph code which was compiled at the instance of the Great Northern Telegraph Company when they introduced the telegraphs into China some 25 years ago, and which is extensively used by the Chinese for telegraphing in their own language.

Whilst the telegrams were in process of transmission, Li Chung Tang was introduced by the Marquis of Tweeddale to Commodore Suenson, of the Great Northern

Telegraph Company, Admiral Sir George H. Richards, K.C.B., and Mr. William Shuter. At luncheon the accomplished Dane, in a speech full of interesting reminiscences, which we reproduce later, recalled the early difficulties the promoters of telegraphs in China had to encounter, the Chinese having fished up the cables to convert the expensive steel and copper wires into nails for their tea chests; but, by and bye, the more enlightened merchants convinced themselves that telegraphy was "neither humbug nor devilry."

The telegraphic feats having come to an end, a tour of inspection was made under the guidance of Mr. F. R. Lucas, manager of the works and Engineer-in-Chief to the company, and Mr. Shuter. His Excellency was enabled to inspect the manufacture of the Borkum-Vigo German Government cable, a large number of machines being in active operation on this contract. Part of the core is covered with brass tape to protect the gutta-percha from the ravages of the teredo, which in shallow water is found nearly all over the globe; in deep water this precaution is not so necessary, except in certain localities. There were also several other cables in course of manufacture, mostly for repairing purposes in various parts of the world.

The finished work was of a kind to delight the heart of a cable expert, and the directors of the Telegraph Construction and Maintenance Company had every reason to feel gratified at the favourable comments overheard at every turn from the large proportion of visitors who were familiar with submarine cable construction.

The ss. *Scotia* belonging to the company, was to be seen outside the wharf waiting to take the German cable away. We may add that the welding of the joints in the sheathing wires is now done by electric heating, a boy being able to do better and faster work than two men using the ordinary forge method. The joints, too, are so perfect that wires never break at the weld, as they were so prone to do previous to the introduction of the electrical process. Doubtless this method will soon become universal in all cable works, for its utility is obvious, even to the non-technical observer. The first cables ever made were turned out at these works. That laid between Dover and Calais, and also the first Atlantic cable, were products of this factory. But although the works are the oldest, they are completely up to date, and cable making goes on in them with as much rapidity as anywhere in the world. Li Chung Tang has been the man who has done most to promote telegraphy in China, and this was the reason for the honour paid to him in the organisation of the entertainment.

The company then proceeded to the spacious and beautifully decorated marquee for luncheon, at which the Marquis of Tweeddale presided. Owing to the fact that his Excellency had to get away some two hours or so earlier than had been anticipated, in order to meet Lord Salisbury in conference, the speeches were delivered between the courses. The pleasure of the day should have been much enhanced by the performances of the band of the Royal Artillery, but on several occasions the music had to be suddenly interrupted for the speeches, which, through the cause to which we have just referred, were perforce given during the luncheon. Cavaliere Zavertal, the accomplished conductor, and his able associates, must have felt that their charming programme was, under the circumstances, more or less wasted, but the exigencies of the situation were fatal to the real enjoyment of the soothing strains which, at other times, are supposed to soothe the savage breast.

To a musician the abrupt termination of one of the most exquisite of Brahm's Hungarian dances almost as soon as it had commenced, was little short of irreverence, and we felt our editorial heart overflowing with infinite sympathy for the gallant artillerymen, and filled with an equally boundless disdain for that very matter-of-fact toastmaster who had such an utter disregard for the "food of love."

> "The man that hath no *music* in himself,
> Nor is not moved with concord of sweet sounds,
> Is fit for treasons, stratagems, and spoils."

We scarcely like to think that 139 of the guests come within this category, but *after* luncheon Schubert's lovely "L'Addio," one of the greatest inspirations of that most inspired of song writers, was performed in the presence of a solitary individual, the fascinations of a gay photographer outside proving too great for 140 — 1.

The chairman, having proposed the toasts of "The Queen-Empress" and "The Emperor of China," which were both received with enthusiasm, next proposed the health of Li Chung Tang in the following words:—

I have now the honour to propose the health of our distinguished guest, Li Chung Tang, and in doing so, it may not be out of place to remark that, although His Excellency is probably little known to the majority of those present to-day, to the Eastern Extension and Great Northern Telegraph Companies, whose cables connect China with the rest of the world, the name of Li Chung Tang is more than familiar, and carries with it the respect and admiration which a life-long devotion to his sovereign and country has assuredly well earned.

His Excellency has been the pioneer, and for the last quarter of a century, I may say, the leader of progress and advancement in the vast Empire which he so worthily represents, and probably few of us, even those connected with the submarine cables, are aware of the immense difficulties he has had to contend with in bringing China to her present position in the sphere of commerce. Not only has His Excellency introduced railways and mining enterprise into the country, but he has been the means of establishing a vast network of telegraphs throughout the Empire, connecting the Russian, Indian and French Government telegraph systems, as well as the submarine cables, with practically all parts of China. This important work was only commenced in 1880, and now nearly 10,000 miles of telegraphs exist in China, and unlike some of the telegraphs in western countries, the Chinese lines pay a substantial dividend on the capital invested in them.

It is not perhaps generally known that in addition to his many other high offices his Excellency has long occupied the important position of Imperial Commissioner of Telegraphs. It was in this capacity that the Eastern Extension and Great Northern Companies had the honour of becoming personally acquainted with his Excellency many years ago, and the negotiations then entered into have since resulted in the conclusion of a friendly working arrangement between the submarine cables and the Chinese landlines. That this may long continue is my earnest wish, and as the arrangement is based on fair and enlightened principles, I have little doubt that it will prove satisfactory to all parties concerned. It affords me much gratification in having this opportunity of publicly thanking his Excellency for all the assistance he has rendered towards the development of telegraphy in the far East, without which it would have been impossible for telegraphy to have reached its present high state of efficiency. In conclusion, I beg to propose long life and prosperity to his Excellency Li Chung Tang.

Li Chung Tang, through his interpreter, made the following highly diplomatic and characteristic reply:—

I have to thank the chairman for the kind words with which he has expressed the sentiments of the companies by whom I have been entertained to-day. We live in a world of evolution, in which there are only two principles—the struggle for existence and the survival of the fittest. These principles always hold good. Telegraphs and railways are the fittest means of communication amongst nations, and the companies who entertain us are doubtless the fittest manufacturers and controllers of one of the best means of communication. They are the true pioneers who work in the new field of this enterprise in the east, and who serve as the best instructors of the Chinese, showing them how to affiliate telegraphics with the prosperity of the Chinese telegraph administration, and reflect the merits of the two cable companies. I have always studied to identify and amalgamate European skill with the prosperity of the Chinese Administration, and telegraphy tends to effect this combination. I hope that other industries will follow the example of the two cable companies who are the pioneers in the East, and which have effected the combination of scientific knowledge with Chinese natural resources, not only for the benefit of England and China, but also of the human race throughout the world. Now I bring my speech to a conclusion. Let us drink to the union of European skill with the unlimited resources of China.

Shortly afterwards, at one o'clock, the Envoy left the luncheon tent for London, much to the regret of the assemblage, between whom and the illustrious Chinese statesman a sympathetic feeling had quickly and intuitively established itself.

To the toast of the Great Northern Telegraph Company, Commodore Suenson, to whom we have already briefly alluded, made the following highly interesting reply, interesting both from the historical and practical points of view:—

Unaccustomed as I am to express myself publicly in English, it is with much hesitation that I venture to address this most distinguished company. It is, however, not only a sense of duty, but also the sentiments of my heart, that prompt me to speak on behalf of "The Great Northern Telegraph Company of Copenhagen," with which I am so closely connected, and to which belongs the honour of having established the first submarine cables in Chinese waters, and the first overhead landlines on Chinese soil. The appreciation of this honour is associated with a feeling of gratitude for the hospitality which my company has so long enjoyed in the Celestial Empire.

In fact, it is now more than 26 years since I, as a young man, went out to China to arrange for the establishment of our first cables, and, to speak the truth, the object of my visit was not greeted with enthusiasm either by the Chinese, who did not yet realise the idea of telegraphy, or by the European residents, who only too well realised the immediate effect of the innovation. I here specially refer to the great commercial firms and houses who were quite aware that the extension of the telegraph lines to China would deal a severe blow to their supremacy by putting an end to the great speculations, and by enabling the small merchants to keep in touch with the movements of the markets all over the world.

However, once laid down, the cables were freely used by the

Europeans and only *too* freely by the Chinese, although not exactly in the way we should have preferred. In fact, large pieces of them were picked up by the Chinamen, and the copper and steel wires were turned into nails for tea boxes; this really was "to add insult to injury." By and bye, however, the intelligent Chinese merchants convinced themselves that telegraphy was neither humbug nor devilry, and that the cables could be used in a more respectful and profitable way.

The object of my company was, however, not only to lay *cables* but also to build *landlines*, which might spread the benefit of telegraphy to the 400 millions of people living within the limits of the Celestial Empire; but here we had to deal with the less intelligent and more superstitious populations of the interior. For ten years we struggled hard and lost no opportunity to further our object. In 1874 and '75 we thought we had succeeded, having obtained permission from the authorities at Fohkien to build a landline between Foochow and Amoy. The country was surveyed and the building commenced by our engineers, but when 30 miles of the line had been erected, it was torn down by the population under the pretext that it interfered with the graves and was offensive to the famous "Fung-shui," that it attracted the evil spirits, and what not. After a whole year's repeated vain attempts we were obliged to give it up, succeeding, however, in saving out of the wreck a short telegraph line between Foochow and Pagoda Anchorage, as well as a telegraph school for the instruction of Chinese pupils.

These and many other efforts in different parts of China, however, paved the way, and had above all the effect of drawing the attention of His Excellency, the present Ambassador Li, to the subject. From the year 1880 I may truly say that His Excellency became the providence of telegraphy in China, as he has been China's providence in many other respects. He gave a contract to my company for establishing a landline between Shanghai and Tientsin, and a telegraph school for young Chinamen at the latter place. This was a considerable work. The line had a length of 900 miles, and entailed the erection of not less than 21,000 telegraph poles, besides the crossing of several rivers by cable. Nevertheless the whole line was built in about five months, and, I am glad to say, to the entire satisfaction of His Excellency. I need not add that all superstitious fears about its interfering with anybody or anything vanished, as soon as it became known that the work was performed under the protection of China's most eminent and all-powerful statesman.

From this moment the development of telegraphy in China may be illustrated by saying that the telegraph poles in China's fertile soil vied in growth with the bamboos. In a very few years a network of telegraph lines was spread over the Middle Kingdom, forced its way even through the Chinese Wall, and now extends to the remotest frontiers of the immense Empire. I am proud to say that most of these lines have been surveyed by, and built under the superintendence of Danish engineers, and I feel sure that my British colleagues and friends, who, with their great predecessors in submarine telegraphy, have covered England with more unfading glory than any other nation will not grudge the small country which was the fatherland of Oersted, and I may add of the Princess of Wales, the honour of having introduced telegraphy in the far East, in China, and Japan. We should never have been able to do so had not British pluck and enterprise, such as has been shown by the Anglo-American Telegraph Company, the present Eastern and Eastern Extension Companies, and others set the example, and had not the necessary experience and materials been supplied by British science and industry, such as are embodied in the grand and magnificent establishment which we have seen to-day.

Allow me to add one more fact and one more reflection to this hurried sketch of the history of telegraphy in China. The fact is this, that although China, since 1884, has been engaged in two wars with foreign powers, neither the Chinese Government nor the French, in 1884 and 1885, nor the Japanese in 1894 and 1895, have interfered with the telegraph cables landed on Chinese territory, or with the service performed by them. They have been allowed to pursue their neutral, useful, and peaceful work to the benefit of all parties concerned, although in the last war they directly connected the two belligerent powers. This is a proof of regard for neutral property, of respect for international telegraphy, and of recognition of the immense services rendered by it, which ought to be noted, and to serve not only as an example worthy of imitation, but also as an argument in favour of the Submarine companies' repeated demands for the neutrality and the inviolability of neutral cables in time of war.

In thanking you for the indulgence with which you have listened to my rather long and I fear rather unintelligible talk, I beg to propose the toast of the still young Imperial Chinese Telegraph Administration, whose creator and protector, His Excellency the Ambassador, is present amongst us. May that Administration prosper and flourish to the benefit and happiness of China, and of all countries who have relations with the Celestial Empire.

Replying to the toast of the Telegraph Construction and Maintenance Company, Admiral Sir George Richards, K.C.B., related in brief what may be said to be the history of the company's achievements. His speech is interesting enough to reproduce in full, so we give the veteran's modest words verbatim :—

Gentlemen,—On the part of the Telegraph Construction and Maintenance Company, I beg to offer to His Excellency our cordial thanks for the honour he has done us in associating the name of our company with the toast he has just proposed, and to you, gentlemen, for the way in which you have received it.

Commodore Suenson, in his excellent speech, has only dealt with the political and other difficulties his company has had to overcome in carrying the telegraph into modern China. I had, perhaps, better confine myself briefly to the practical, all round question, of the laying and maintaining of these great ocean lines; it is a little difficult to deal with one's own achievements in public, and my colleagues have always been averse from dwelling on what the company has done or is going to do. We prefer to leave that to the telegraph companies whose great works we have carried out during the last 30 years, with whom we have always been on terms of the greatest confidence and harmony, and who are so well represented here on this occasion; and we have been always ready to accept their verdict.

We are all known as telegraph companies, but the difference is that the one establishes, owns and works the cable, and has its difficulties, political and otherwise, with foreign countries, while the other manufactures and lays and maintains the cable at the bottom of the sea; its difficulties and risks are of a technical nature, incident to the elements and the depths of the ocean, and have been solved, so far as they may be, by the skill of the seaman and the engineer.

Gentlemen, if I depart to-day from the modest reticence which is most congenial to ourselves, I trust you will impute it to the exceptional nature of the present occasion. We don't feel that it would be proper or respectful to our illustrious guest to withhold from him any information which he has shown so much anxiety to obtain on all subjects. I will, therefore, recapitulate briefly the nature and extent of the works which we have carried out during our comparatively brief existence of little over 30 years; still, we are the most ancient cable manufacturing company in the world. The earliest of our great works was the laying of the first Atlantic cable in the year 1865, after many difficulties; since then we have successfully laid, I think, six cables between Great Britain and North America. More recently, we may say—I hope with pardonable pride—that we have carried out all the great telegraphic enterprises conceived by the great father of ocean telegraphy, Sir John Pender, who has recently been removed from among us, and whose name must always be conspicuously remembered in connection with those achievments. Thus in a comparatively brief period Great Britain has been connected with Lisbon, which has been made one of the great centres of marine telegraphy, thence with the Mediterranean, Malta, Egypt, through the Red Sea to Aden, Singapore, India, Hong Kong, Australia, and New Zealand, besides the Cape of Good Hope and Brazil. It is true the globe has not yet been girdled across every ocean, although this will probably be done, but both sides of it have been brought together, and every continent and considerable island and place of importance have been connected with this country, generally by duplicate, often by triplicate, lines of telegraph.

In carrying out these works, this company alone has manufactured and laid something over 116,000 miles of cable.

I believe there is no finality for the electric cable, and I am sanguine enough to predict continued prosperity for it in the generations yet to come.

The following, in addition to the noble chairman and the Chinese visitors, is a list of the guests who had accepted invitations:—Mr. B. C. G. Scott, Admiral Sir J. Commerell, Sir Donald A. Smith, Sir Albert Rollit, Lt.-Gen. Sir Andrew Clarke, Admiral Lord John Hay, Sir Malcolm Fraser, Sir Eyre M. Shaw, Mr. J. Howard, Mr. S. Barber, Mr. Latimer Clark, Commodore Suenson, Vice Admiral Tracey, Mr. J. C. Lamb, Sir C. R. Lighton, Sir Saul Samuel, Professor Crookes, Sir David Tennant, Sir Henry Mance, Hon. Thomas Playford, Mr. Louis Floersheim, Mr. F. C. C. Nielsen, Mr. Suenson, jun., Mr. H. C. Forde, Mr. F. E. Hesse, Mr. Keswick, Mr. G. W. Campbell, Hon. A. C. Brodrick, Mr. W. H. Axworthy, Mr. W. S. Smith, Mr. G. C. Bompas, Admiral Sir A. H. Hoskins, Capt. Scott Smith, Mr. R. Peake, Mr. H. F. Hesse, Mr. G. M. Davey, Mr. C. F. Venndt, Capt. Trott, Dr. Cæsar, Capt. Kennedy, Mr. M. F. Roberts, Mr. W. T. Ansell, Capt. Lang, Mr. W. R. Lyne, Mons. C. Guernier, Mr. A. Dearlove, Mr. G. R. Elphinstone, Mr. A. D. Shuter, Mr. E. Dickens, Dr. Allchin, Mr. G. von Chauvin, Sir A. J. L. Cappel, Mr. J. Boon, Mr. T. A. Bullock, Dr. Wholey, Mr. G. R. Nielson, Mr. P. Glegg, Mr. W. A. Pickering, Mr. A. G. Angier, Mr. J. Latey, Mr. A. Hanson, Mr. H. A. C. Saunders, Dr. P. Scott, Mr. F. R. Lucas, Mr. G. H. Pember, Mr. J. Campbell, Mr. J. D. Campbell, Admiral Sir W. Dowell, Admiral Sir G. H. Richards (vice-chairman), Mr. H. W. Lucy, Mr. F. Dawes, Mr. A. E. Shuter, Mr. F. le B. Bedwell, Mr. H. Thwaites, Mr. G. Draper, Colonel Walters, Mr. C. E. Günther, Mr. J. Coppen, Mr. J. H. Hart, Mr. R. London, Capt. Woodcock, Capt. Manning, Mr. W. O. Smith, Mr. O. Moll, Mr. L. L. Hartvigsen, Mr. F. Youle, Prof. Fleming, Mr. M. Corder, Mr. C. B. Barnes, Mr. T. Clark, Mr. C. Crook, Mr. H. L. Smith, Mr. W. H. Baines, Capt. Cato, Mr. J. C. Parkinson, Mr. J. Denison Pender, Mr. E. Riddle, Capt. Gifford, Capt. Seymour, Mr. S. Collett, Mr. Youngson, Mr. R. M. Cunningham, Mr. J. Lloyd, Mr. W. P. Granville, Mr. T. Finnis, Mr. J. R. Reidy, Sir R. W. G. Herbert, Mr. L. Schott, Mr. D. H. Goodsall, Mr. R. Collett, Mr. J. Gane, Mr. C. Gerhardi, Mr. W. Shuter, Mr. W. C. Johnson, Mr. H. Clifford, Mr. R. T. Brown, Mr. H. Holmes, Capt. Ingles, and representatives of the *Times*, *Standard*, *Daily News*, *Daily*

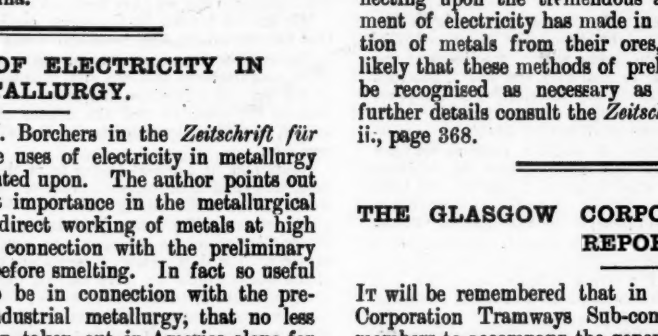
*Chronicle*, *Morning Post*, *Daily Telegraph*, *Daily Mail*, *Hong Kong Press*, *The Globe*, Press Association, Foreign Press Association, *The Electrician*, and the ELECTRICAL REVIEW.

About 2.30 the company separated, and so ended a day memorable in the history of the three companies, and long to be remembered by those who were privileged to meet the "Grand Old Man" of China.

## SOME USES OF ELECTRICITY IN METALLURGY.

IN a recent paper by W. Borchers in the *Zeitschrift für Elektrochemie*, some of the uses of electricity in metallurgy are described and commented upon. The author points out that electricity is of great importance in the metallurgical industries, not only the direct working of metals at high temperatures, but also in connection with the preliminary preparation of the ores before smelting. In fact so useful does electricity appear to be in connection with the preliminary operations of industrial metallurgy, that no less than 170 patents have been taken out in America alone for processes whereby the magnetic and non-magnetic portions of a mixture of ores can be separated by electro-magnetic contrivances.

In actual practice electro-magnetic preparation has been applied for the most part to the ores of iron, lead, and zinc, and in order to exhibit the nature of the many metallurgical processes in use and the part played by electricity in them, W. Borchers exhibits in a tabular form the various processes for reducing and separating metals extant. The table is reproduced in simplified form. Empty spaces opposite the name of a metal indicate that the methods of the corresponding vertical columns are not applied to it. Spaces ruled with fine vertical lines indicate methods in which electricity is not used. Spaces ruled with thick-horizontal lines indicate electrical methods.




We first come to those under the head of reduction of oxides by heat; in these cases, however, electricity is only employed as a means of producing a high temperature. But it is not unimportant to notice that all oxides (naturally with the exception of carbon monoxide) can be reduced by this method in presence of carbon. The Cowles process of manufacturing aluminium bronze was the first important application of this principle. W. Borchers has shown that chromium, manganese, and tungsten can be prepared in the same way, although chromium and tungsten have a very high melting point.

In the chemical decomposition of sulphides and salts, electrical methods have found no application; but after this we come to processes which are entirely electrical. It will suffice to point out that the only metals not included in the columns for electrolysis of aqueous solutions are fused compounds of iron, mercury, and tungsten. Even these can be prepared electrolytically, but as yet the electrical methods have not been able to compete with the others.

Among present applications of electrolysis may be mentioned the refining of metals and the manufacture of metallic objects (Elmore, Klein), the reduction of aluminium, the separation of gold and silver, the extraction of gold by the cyanide process and electrolysis, electro-deposition of zinc, &c.

Hitherto electricity has played but a small part in the great iron industry, but strenuous efforts are being made to apply it both in the preparation of the raw material and in the subsequent processes of manufacture. On carefully reflecting upon the tremendous advances which this department of electricity has made in connection with the production of metals from their ores, it appears to us extremely likely that these methods of preliminary treatment will soon be recognised as necessary as well as convenient. For further details consult the *Zeitschrift für Elektrochemie*, Vol. ii., page 368.

## THE GLASGOW CORPORATION TRAMWAY REPORT.

IT will be remembered that in February last the Glasgow Corporation Tramways Sub-committee deputed one of its members to accompany the general manager upon a preliminary tour of inspection to various places on the Continent where might be found the newest and best modern installations of mechanical tramway traction; and in consequence of this resolve, a long and elaborate report by the two gentlemen in question was put before the committee four or five months ago. Amongst the systems thus investigated we may recall those at Brussels, Hanover, Hamburg, Berlin, Dresden, Buda Pesth, Vienna, Milan, Genoa, Paris and Rouen; but as the report embodying the results of this journey was published soon after its issue to the committee, we do not need to discuss it further at the present moment, beyond saying that it was used as a valuable guide for the larger deputation which visited later on some of the principal places where electric traction is in evidence, and which has since then drawn up a secondary report just now issued, dealing almost entirely with electric traction, both with overhead wires and conduit devices (the latter very exhaustively, and to a greater extent than has hitherto been attempted).

The practical limitation of the full committee's report to electric traction was, of course, due to the conclusions arrived at by the preliminary investigation of Mr. Councillor Crawford and Mr. John Young, the general manager, and it will be advantageous to reproduce these conclusions at the present moment, in view of the expressions from some of the other members of the Council. Messrs. Crawford and Young came to the deliberate opinion, after visiting the places above named, and inspecting the tramway systems at each one, that (1) "The time has arrived when the Glasgow Corporation should make arrangements for beginning, as soon as they conveniently can, to work some of the tramways by mechanical traction; (2) The overhead system of electric traction is the best we have seen, and can be made quite applicable to any part of the city; (3) the Corporation should begin by testing this system on one important route . . . .; (4) in the erection of the overhead lines, the cross-span wires should be fixed to buildings wherever practicable; (5) the installation at Hamburg, being the largest installation of

electric traction in Europe at present, is one which should be specially included in the list to be inspected."

Based on this preliminary report, and the mass of facts and figures therein contained, the sub-committee itself has now issued a report, from which we abstract the principal conclusions. First may be cited the statement that the conditions for mechanical or improved traction in Glasgow are best fulfilled by the use of electricity; then it is admitted that the overhead system has practically superseded horse traction in America, and has begun to do so on the continent of Europe also. "It is the simplest and cheapest to construct and work, the most accessible for maintenance and repairs, and on the whole the most efficient system of mechanical traction which has yet been demonstrated by practical working. If constructed on the most improved principles, the overhead lines are *not* seriously offensive to the eye, and a short acquaintance with them very soon removes preconceived objections." Finally, says the sub-committee, the only choice left the Corporation is "either to test the overhead system on one route, or abide by horse traction for a time, and watch developments." These are very weighty remarks, and it seems somewhat inexplicable that, after the sub-committee had come to such conclusions, the Tramways Committee itself should not be unanimous in the matter, the convener's casting vote only securing the adoption of these recommendations, whilst, in the general Council meeting, the convener himself "recanted," and asked for the question to be further remitted to the Committee!

In commenting, last week, upon the delay now likely to take place, we expressed an opinion which may be emphatically repeated, that the Corporation itself must, and ought to, *lead* public opinion in the matter, and not wait for an indefinite education of aesthetic taste as regards the beauties or otherwise, of overhead wires. We should have thought that a pre-eminently practical city like Glasgow would prefer the certainty of cheap, rapid, and efficient street transit to any prospect of maintaining streets (not particularly beautiful in themselves—compared with those of Milan, for instance) free from the "pollution" of overhead wires that usually pass unnoticed and almost unseen.

Turning, however, from the endless question of public taste to the sub-committee's report, we find many points of interest regarding electric traction in general, and trolley *v.* conduit in particular. It states, at the outset, that the previous report was at once agreed with, in so far as it concludes that electric traction holds the field as a substitute for horse traction; then goes on to mention briefly the places and systems inspected—Coventry, Bristol (said to be owned by the Imperial Tramway Company, which may be really, but certainly is not nominally the case). The cars here are moreover stated to be equipped with 2·25 H.P. motors—a method of writing "two 25 H.P." which might delude the uninformed into thinking the motors ten times smaller than they really are—Brussels, Hamburg, Berlin and Hanover.

Then the report states that the overhead system has outstripped every other: but with a view to superseding the overhead wires, a great many conduit systems have been patented and experimented with. Under the heads of I. open conduit, and II. closed conduit or magnetic systems, the report deals with "a few of these"—eleven in the first class, eight in the second. A more incisive blow at conduit systems generally could hardly be dealt by their worst enemies than this calm examination of all their expensive complexity by a committee anxious, if possible, to find some system with features sufficiently redeeming to secure adoption. Of those in the first group, we may mention the Holroyd-Smith (Blackpool); Siemens and Halske (Buda Pesth); and Thomson-Houston (Berlin, Brussels and New York), as the only systems actually at work; and nothing very favourable is said about any one of them in regard to its adoption for Glasgow. The others in this group are hardly worth mention as really practical schemes or methods, and some will be quite new to our readers. We give them at their face value:—(1) Lave system; (2) Douty system; (3) Simplex (better known, perhaps, as the Waller-Manville; if we mistake not); (4) Petersen's double compartment; (5) Griffin, ditto; (6) Bergwerks Verein; (7) Perkin's watertight; and (8) Connett. Truly an elegant display of ingenuity somewhat misapplied, the chief remark about each being, "This system is being experimented with, is not in operation, has not yet been in use, &c."

The same remarks could be made about the second group, only perhaps "more so," beginning with the Johnson-Lundell (our old friend, the Lineff system, come to life again as a double-barrelled big gun), and ending with the very last—that of Pringle & Kent, which we lately described and illustrated. The only really practical one of the whole crowd in the closed conduit systems seems to be that of Wheless, as developed by the Westinghouse Company. Both Pringle's system and that of Claret & Vuilleumier (commonly known as the "claret and vinegar"), are calculated to please the eye of a watchmaker or instrument designer, rather than a mechanical engineer (which is what every electrical engineer ought to be at bottom): the Brain system is ingenious, but might lead under the wheels of ordinary street traffic to the flinging about of too much bar iron for public safety. The Munsie-Coles, the Henry, and the electro-magnetic (McLaughlin's), are all variants of the Westinghouse method, with the added disadvantage in the latter case of operating magnetic switches through the iron lids of street boxes! The first-named, moreover, gives one the impression of serving well to diminish the number of horses in the streets by promotion to the "happy hunting grounds," rather than fields of mundane usefulness in other directions.

In short, we cannot compliment the Glasgow citizens and Corporation on being commonly wise, let alone "canny," if this report does not convince them that the one and only method—at any rate to begin with—is the overhead wire system for use on their tramways; and that the various conduit systems, of whatever type they may be, are only expensive and complicated substitutes, which entail constant trouble with hardly any corresponding advantages.

We have no space for lengthy comments upon the subsidiary reports of Mr. Clark, the city engineer (though he gives some very instructive figures as to the probable cost of equipping a line with overhead wires or conduits, the estimates being for the Kelvinside-Dennistoun route—£26,000 and £60,000 respectively—and dismisses in few words as being nothing like the probable cost of an estimate of Pringle's system at £4,600 per mile!), nor yet for Mr. Arnot's remarks, which are largely critical, on the question of underground or conduit systems. He says—and we decidedly agree with him—that of all the underground systems, he considers that adopted at Buda Pesth to be the most preferable; but it is evident that his tendency in the brief report he makes is to say the best he can for conduit systems, and that is a poor one. We should much like to have his views on overhead wires; his only remark thereon is brief, but important—the Board of Trade regulations are easily complied with under their use. Reading between the lines, we suspect Mr. Arnot of purposely refraining from saying what he might do in favour of overhead wires (unless he was specially asked to criticise conduit methods alone), because their advantages are manifest, and axioms hardly require proofs.

If this be so, we trust it will not be long before most of the good Glasgow people share his opinions, and thus lead the way (in company with Leeds) in adopting the best and most improved system of traction for ordinary city and suburban streets.

## TRACTION DIAGRAMS.

By THOMAS TOMLINSON, B.E.

(*Continued from page* 163.)

I SHOULD like before passing to other points to refer again to the composite diagrams, of which an example was given in the last article (fig. 16, page 162).

What I then showed was:—(1) That you could obtain by graphic construction a diagram showing the total power (as measured at the car axles) necessary to keep a certain number of cars running at constant speed, and without stops; (2) that this diagram showed a quite remarkable variation in power from point to point; (3) that this diagram tended continually to recur, as the basis of the central station output curve, at intervals as given by the "headway" between cars.

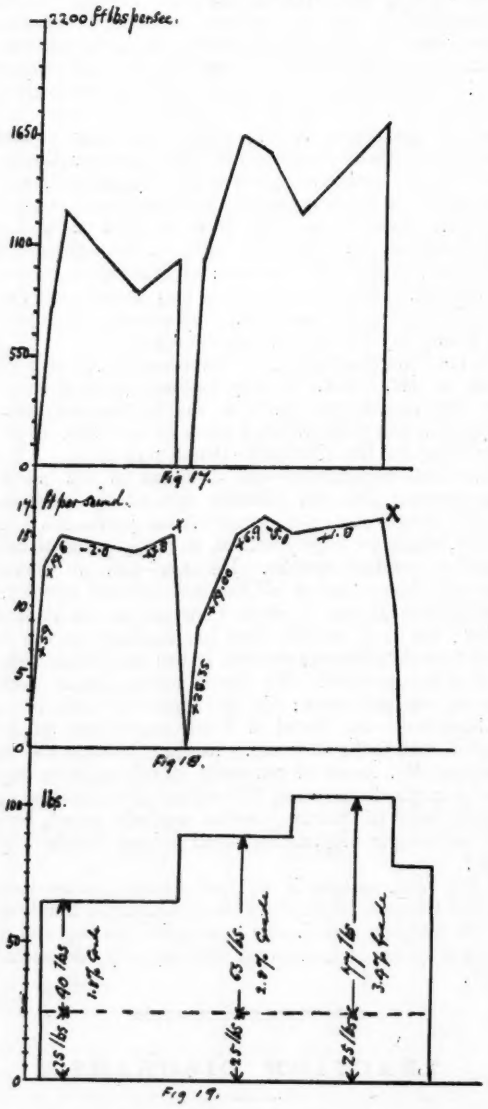
The first question is, assuming the car's speed to be uniform and that there are no stops—to keep issues simple for

the present—How will the central station output diagram be related to the combined full diagram?

It will be prevented from being mathematically similar by the varying losses in motor, gearing, regulator resistance and line resistance, and, further, by the action of the engine fly-wheel, which will make it unnecessary for the steam to follow every little peak and cavity of the combined diagram.

These various causes would prevent its being mathematically similar, *i.e.*, having its ordinates everywhere in same proportion to corresponding ordinates of the composite diagram, but would still leave the connection between the two perfectly determinate.

There is another cause, however, where, from the intrusion of the human or personal element, very wide divergences may result, and divergences without any particular law.




What I allude to is this:—Suppose eight cars to be running, and a suddenly increased demand to be made on one or more cars, this is instantaneously replied to by an automatic re-division of the then available energy in advance of the action of the governor; but this leads to two things: (1) a slowing down of all cars, and (2) a drop in the voltage. If now, to meet the slowing down of the cars, the drivers open up their switches and demand more, then when the governor does act, it acts as if to supply a demand larger than that which rightly exists, this leads to a partial shutting off of current from some of the cars, which again increases the supply to others, from which it is in turn shut off partially until finally the governor again acts to cut off steam, making the supply of power less than actually required, and so on.

Here are possibilities of the very widest variations superposed upon the variations necessitated by the tram line section, and variations depending entirely upon personal characteristics, and the extent of which, therefore, it is impossible to foresee.

The only way in which this source of variation can be met is by having a very quick-acting governor on a simple engine, and motormen so trained that they don't habitually and needlessly defeat the governor action by nervous handling of the switches.

It is obvious that the more variation can be shown to be due to the tram line section, the less is left to be accounted for by coincidence of many stops and starts, and the less we have to attribute our central station variations to continually-recurring coincidences of many stops and starts, the more satisfactory it will be, because (1) the chances are decidedly against such continually-recurring coincidences, and it is decidedly straining probabilities to drag them in as an explanation of the ordinary variations; (2) the chances of successfully dealing with the central station variation are very much increased, if it can be shown that they are in the main periodic.

With regard to the question of the effect of a certain number of simultaneous starts—gone into in the last article—the addition made was of the accelerating pulls of two cars (105 lbs.) at the highest point of the curve. It must be remembered, however, that the pulls per car allowed are the pulls necessary, if steadily applied throughout the whole period of acceleration, to produce the required speed. To produce the same speed within the same distance, by means of a pull or torque which, like that of an electromotor, begins at a maximum, and reduces to nothing, needs a starting pull or torque double this; because in the latter case the total energy expended on acceleration, in foot pounds, is represented by the area of a triangle, and in the former by the area of a rectangle upon the same base, and as these are equal in area (the final acceleration being the same), it is evident that the vertical height of the triangle must be double that of the rectangle, under the very best possible circumstances of equal efficiency in both cases.

The starting of one car, therefore, under the actual conditions, has the same effect in "peaking" the diagram, as would two under conditions of ideal starting as assumed before.

The maximum pull or torque was much in excess of this under the old plan of starting, but will be much closer to it under the series parallel plan, which simply takes the start in two stages, each having the maximum accelerating pull or torque at the beginning, and decreasing to nothing. I think the effect of these two stages will be to increase the value of the maximum torque during acceleration above the theoretical value; of double that necessary for steady acceleration.

Looking at the big effect of a single start—at the known proportions between maximum and mean demand in small electric railways—and at the large disproportion between maximum and mean demand which fig. 16 and others show to exist due to grade alone; it seems a reasonably fair inference that the bulk of the variation is caused by the grading, and that it is not necessary to suppose any constantly recurring coincidences of many stops and starts to interpret the variations of the central station output curve.

If any gentleman in charge of a central station supplying an electric railway wishes to test the relationship between the combined diagram and the central station output curve, and to test in particular the recurring tendency at headway intervals, let him remember that he must get his output curve as a curve of watts, and preferably by a self-recording instrument.

I now pass to the consideration of a matter already alluded to in these articles—the plotting of the actual power required from point to point of a given tram line (for which the section and the drawbar pull to overcome friction $p$ are known) in making a run according to a given speed curve.

The manner of doing this is shown in figs. 17, 18, and 19, in which fig. 19 is the combined friction and grade diagram. Fig. 18 is the speed curve for the run, the figures marked upon it being the allowances in lbs. (per ton) due by way of addition or diminution to the figures taken from fig. 19, on account of the acceleration or retardation of the car at the

time. These figures are got by the use of the formula already used.

$$p_1 \times \text{distance run} = \frac{2{,}240}{2\,g}\,(v_1^2 - v_2^2) = 35\,(v_1^2 - v_2^2)$$

Where $p_1$ is the figure sought, and $v_1$ and $v_2$ are the velocities in feet per second at end and at beginning of the distance over which the acceleration or retardation takes place.

Fig. 17 is the brake horse-power diagram, and represents the product of velocity by actual resistance (after addition or deduction, as above).

It will be seen, then, that from the grade diagram (and the value of $p$ for the run) and the speed diagram, it is rarely possible to plot a diagram, as fig. 17, which will give the actual expenditure of power required from point to point per ton. If we know weight, we can construct actual B.H.P. curve, and compare this point for point with the E.H.P. curve as plotted from volts and amperes supplied.

(*To be continued.*)

## ELECTRIC REPULSION.*

By Prof. I. THORNTON OSMOND.

All text books on electricity state, as a law, that "like charges repel!" But is there any such thing as electric repulsion in the sense of a mutual force action of separation? It is true that two bodies bearing like charges move apart, if free to do so. Naturally, the first explanation was to conceive a repulsion, and this important idea immediately crystallised into a law that has endured and has permeated all electrical literature, and now adds to the difficulties of electrical studies a needless complication of error.

Will not the next author who writes, or who thoroughly revises, a work on electricity omit the false doctrine? Let him follow some such method of treatment as here outlined:

(1) In any operation of electrifying there are always two (or more) bodies having electrification of different kinds.

(2) Whenever an electrified body is brought near other bodies, the latter have the opposite kind of electrification on the parts toward the former.

(3) Between bodies of unlike electrification there are lines of force that tend to shorten and so draw the bodies together, if one or both be free to move.

(4) Two bodies of like electrification and near together are drawn apart because each has lines of force drawing it to other bodies of unlike electrification, but has no lines drawing it in the direction of the other body of like electrification.

By thus bringing to the front, or second place, the fact that every charged body is connected by lines of force (that tend to shorten) to others having unlike charge, all need for a repelling action between like charges vanishes; electric force, like gravitation force, acts only attractively. Gravitation was formerly thought to act as repulsion on certain states or conditions of matter, to account for the moving apart of the earth and bodies that rise in fluids, as smoke in air, wood in water, &c. An advance in physical knowledge has caused this false doctrine of gravitation to pass out of science. Let "like charges repel" so pass.

Is it true that "like magnetic poles repel?"

* New York *Electrical Engineer*.

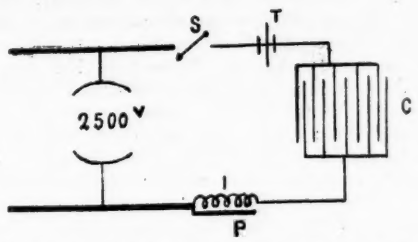
## CORRESPONDENCE.

### Alternate Current Rushes in Condensers.

I notice an interesting series of articles on the subject of alternate current rushes into condensers is being published by an Oxford scientist with a prepossessing name, and as I last January commenced a series of experiments on the same subject, a statement of one or two observed effects may be of interest to some of the readers of the above articles, although a continuation of my experiments was postponed to make time for other research work.

The apparatus employed in these experiments consisted of a one-third microfarad condenser with thick resinous paper as a dielectric and copper for the conductor, a thin brass plate, a coil consisting of six turns of double cotton covered wire and a single pole switch which could be used to make and break the circuit quickly or slowly according to the kind of break required.

The connections are shown in the following diagram:—




S is the single pole switch; C, the condenser; I, six turns of No. 14 B.W.G. copper wire double cotton covered; P is a thin broad brass plate making contact with one end of the coil, I, and supporting the weight of the wire forming this coil; T is a series of very fine silk fibres of different length stuck on to one conductor as shown.

On making or breaking the circuit very quickly with the switch, S, the fibres behaved in a very erratic manner, sometimes giving a kick and trying to stand pependicularly with respect to the conductor on to which they were fixed, then they would become limp and gradually lie down again, the strength of this kick varying from zero up to a very pronounced erection.

When the circuit was made and broken more slowly so as to admit and insure an arc of longer duration at the points where the switch broke the circuit, the fibres would stand away from the conductor as if the force of repulsion acting on them was that due to 25,000 volts, rather than to the applied pressure which was 2,500 volts, and which was unable to cause the fibres to lift even slightly.

If the fibres were chosen of suitable lengths and one pole was brought near that part of the other pole on which the fibres were fixed, these fibres soon began to vibrate periodically and in synchronism with the alternating stress existing between the two mains of opposite polarity thus brought near together, but this is deviating from our subject somewhat.

When the circuit was made and broken quickly by the switch, S, a spark would sometimes pass between the brass plate, P, and the end of the coil, I, although the coil was insulated with a double covering of cotton and there were only six turns in the coil; this spark became much more frequent when the circuit was made and broken slowly, *i.e.*, an arc existed at make and break for a short time, sometimes two or three sparks would pass at one make or break of the switch and invariably they were the vicious white type and accompanied by a sharp cracking sound, in fact, they seemed identical in their nature with the familiar oscillatory discharge from a Leyden jar.

The appearance and existence of these sparks established in my mind the fact that the current passing into and out of the condenser was, at the time of make and break through an arc, one of a very high frequency, and not that due to an alternating pressure such as that applied from the mains, the number of pulsations per minute of this applied pressure being only 5,000.

The behaviour of the fibres at different times was a direct proof that a *very* high P.D. often existed between the mains after breaking the circuit, for they stood erect with a commendable determination, subsiding gradually, in time, as the charge exhausted itself by leakage.

These experiments were merely qualitative, it being my intention to carry out a systematic series of tests on this subject later on when time permitted, but since articles are now appearing in this journal I thought it better to publish these results so that they might be read with other records of experiments conducted on similar lines.

A. F. Berry.

### York Electric Lighting.

Whilst agreeing with your remarks with reference to the above question, I am more sanguine of the ultimate success of the scheme by the Corporation. It is true that our famous anti-electric light committee are active in the matter, and are interesting themselves in the return of candidates

who are sufficiently pliable for their own purposes. It may interest you to give you the balance of parties, when the proposed electric lighting scheme was before the "York Corporation." Mr. Councillor Lambert's resolution involved the rescinding of all former resolutions in the matter. For the resolution, 9; against, 17; neutral, 6. Only one or two of the 17 are favourable to a private company. At present Professor Kennedy is preparing specifications. I believe the majority of the Corporation have come round to the opinion in consideration of the city debt—£485,797 18s. 7d. and £69,527 12s. 10d. to be raised by rates, and that no private interests has been yielded to them through the agency of municipalisation; the time has arrived when some profitable enterprise should be developed for the benefit of the ratepayers. Considering what a wide comprehensive subject electricity is, its advent has not provoked much discussion in York, which I think is owing to the public being inadequately informed in the matter. Very few technical points have been discussed in any of the daily papers of this country.

Might I be permitted to enjoin upon managers of electrical papers the need of their useful studies and valuable information finding its way into the columns of the daily papers. We have sometimes, *e.g.*, letters setting forth the leading points of the "Light Railway Bill," and other matters of public interest—written by various secretaries, dealing for the most part with technical points in a precise manner. For instance:—

1. The public are most concerned about the present cost of electricity.

2. The average reader knows very little about its future prospects.

3. Want of knowledge makes them an easy prey to those interested in the gas companies.

In York, three leaders of public opinion (or interested persons) have made the statement that gas was 12 or 15 times cheaper than the electric light; and as yet have not attempted to prove it.

A great deal of good would result if my suggestion was carried out, say, if a letter dealing with instructive points was sent to the offices of the leading newspapers in each town in the kingdom.

**James Bousfield.**

[Mr. Bousfield sends us with this letter copies of correspondence which he has sent to the *Yorkshire Herald*, as well as replies to it. Mr. Bousfield has put the case so well, and at the same time so fairly for electric lighting, that if every town possessed such a champion of electric lighting the public would be amply informed of what is being done in electrical work.—Eds. Elec. Rev.]

### High Voltage Lamps.

I notice in your issue of the 14th inst., in an article on "American Experience with High Voltage Lamps," that you indirectly refer to an article by the writer, published in the *Electrical World* of New York. This article, by a typographical error, stated that most of the high voltage central station plants in the United States had a maximum capacity of 300 lamps of 16 candles, or 600 of 8 candles. This should have read 3,000 of 16 or 6,000 of 8 candles, which is quite a different matter from the statement as published. Thanking you for making this correction.

**W. N. Stewart.**

London, *August 19th*, 1896.

## BUSINESS NOTICES, &c.

**Braulik v. Darton.**—Before Mr. Julian Robins, the assistant judge at the City of London Court, on Monday last, the plaintiff, Mr. G. Braulik, electrician, of 217, Upper Thames Street, sued the defendants, Messrs. F. Darton & Co., 146, St. John Street, Clerkenwell, to recover £7 4s. 5d. for electrical bells sold and delivered. The defence set up was that the bells supplied were the wrong size. They were not according to the sample submitted by the traveller, and measured 2½ inches instead of 2¾ inches. Evidence was heard on both sides, and his Honour said it appeared to him that there had been a mutual mistake, and that no agreement was ever arrived at. He gave judgment for the defendants.

## Electrical Wares Exported.

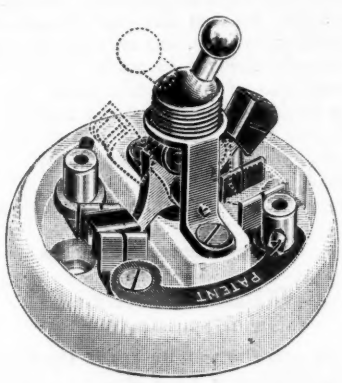
| Week Ending Aug. 18th, 1895. | £ | s. | Week Ending Aug. 18th, 1896. | £ | s. |
|---|---|---|---|---|---|
| Aden. Teleg. mtl. ... | 25 | 0 | Aden. Teleg. cable ... | 16,809 | 0 |
| Alexandria. Teleph. mtl. | 215 | 0 | Alexandria. Teleg. mtl. | 60 | 0 |
| Algoa Bay ... ... | 250 | 0 | Archangel ... ... | 88 | 0 |
| Amsterdam ... ... | 15 | 0 | Beira. Teleg. mtl. ... | 757 | 0 |
| Arendal. Teleg. cable | 2,200 | 0 | Bombay ... ... | 30 | 0 |
| Brisbane ... ... | 80 | 0 | Brussels ... ... | 68 | 0 |
| Buenos Ayres ... ... | 98 | 0 | Calcutta ... ... | 1,699 | 0 |
| „ Teleg. mtl. | 645 | 0 | Cape Town ... ... | 251 | 0 |
| Calcutta ... ... | 758 | 0 | „ Teleg. mtl. | 151 | 0 |
| Cape Town ... ... | 430 | 0 | Copenhagen ... ... | 52 | 0 |
| Delagoa Bay ... ... | 140 | 0 | East London ... ... | 550 | 0 |
| Hamburg. Teleg. mtl. | 208 | 0 | Flushing ... ... | 10 | 0 |
| Havre ... ... ... | 39 | 0 | Gandia... ... ... | 635 | 0 |
| Madras ... ... | 31 | 0 | Hong Kong ... ... | 16 | 0 |
| Mauritius ... ... | 47 | 0 | Iquique ... ... ... | 25 | 0 |
| Melbourne ... ... | 188 | 0 | Liban ... ... ... | 64 | 0 |
| Monte Video ... ... | 60 | 0 | Malta ... ... ... | 30 | 0 |
| „ Teleg. mtl. | 159 | 0 | Melbourne ... ... | 22 | 0 |
| Rockhampton... ... | 19 | 0 | „ Teleg. mtl. | 890 | 0 |
| Rosario. Teleg. mtl. | 179 | 0 | Port Elizabeth... ... | 393 | 0 |
| St. Petersburg. Elc.launch | 550 | 0 | Rosario. Teleg. mtl. ... | 1,122 | 0 |
| Shanghai. Teleg. mtl. | 33 | 0 | Shanghai ... ... | 70 | 0 |
| Wellington ... ... | 106 | 0 | Singapore ... ... | 1,116 | 0 |
| „ Teleg. mtl. | 63 | 0 | Stockholm ... ... | 23 | 0 |
| „ Teleph. mtl. | 303 | 0 | Sydney ... ... ... | 714 | 0 |
| | | | Wellington ... ... | 328 | 0 |
| Total | £6,841 | 0 | Total... | £25,973 | 0 |

## Foreign Goods Transhipped.

| | £ | s. |
|---|---|---|
| Buenos Ayres ... ... | 33 | 0 |

**Another Claim against the Central London.**—If you want to secure a certain sum as compensation, claim double the amount, seems to have been the policy of Mr. Robert William Clarke, a Bayswater ironmonger, who sought to recover from the company the sum of £12,500 as compensation for the compulsory acquisition of his premises, situate at the Coburg Road and the Queen's Road, for the purposes of the construction of the new line. The matter came—or should have come—before Mr. Under Sheriff Burchell and a special jury last Friday, but as soon as the jury had been sworn in, counsel consulted together, with the result that it was agreed to enter a verdict for the claimant for £6,500. This is highly successful from the company's point of view. The directors and their solicitors are having a great deal of litigation over these claims, but on each occasion, so far, they have secured reduced valuations for the various properties, which have well repaid them for taking the matter into court.

**A Two-Way Tumbler Switch.**—Messrs. Veritys have sent us an illustration and particulars of a new two-way tumbler switch which they have just completed, and have in readiness to submit to the trade. It is claimed to be a great improvement on all previous devices designed for this purpose. A rigid metal rocker, furnished with copper contact pieces at each end, is pivoted between the usual uprights of a tumbler switch. The rocker is acted upon above by a vulcanised fibre roller in connection with the handle knob, and below by a powerful spring. Movement of the handle reverses




the position of the rocker, allowing the current to pass in to one or other of two circuits. One of the chief features of the switch is the exceedingly long break, which we are given to understand will also be a salient point in Messrs. Veritys' new tumbler for 200 volt circuits to be shortly placed upon the market. Our readers are doubtless conversant with the extremely useful application of two-way switches for corridor and bedroom lighting, and they will find Veritys' type answer the purpose admirably. This mode of wiring—by which one lamp can be lighted or extinguished at either of two points—is exceedingly convenient, and will no doubt be extended, especially as good switches are to be procured.

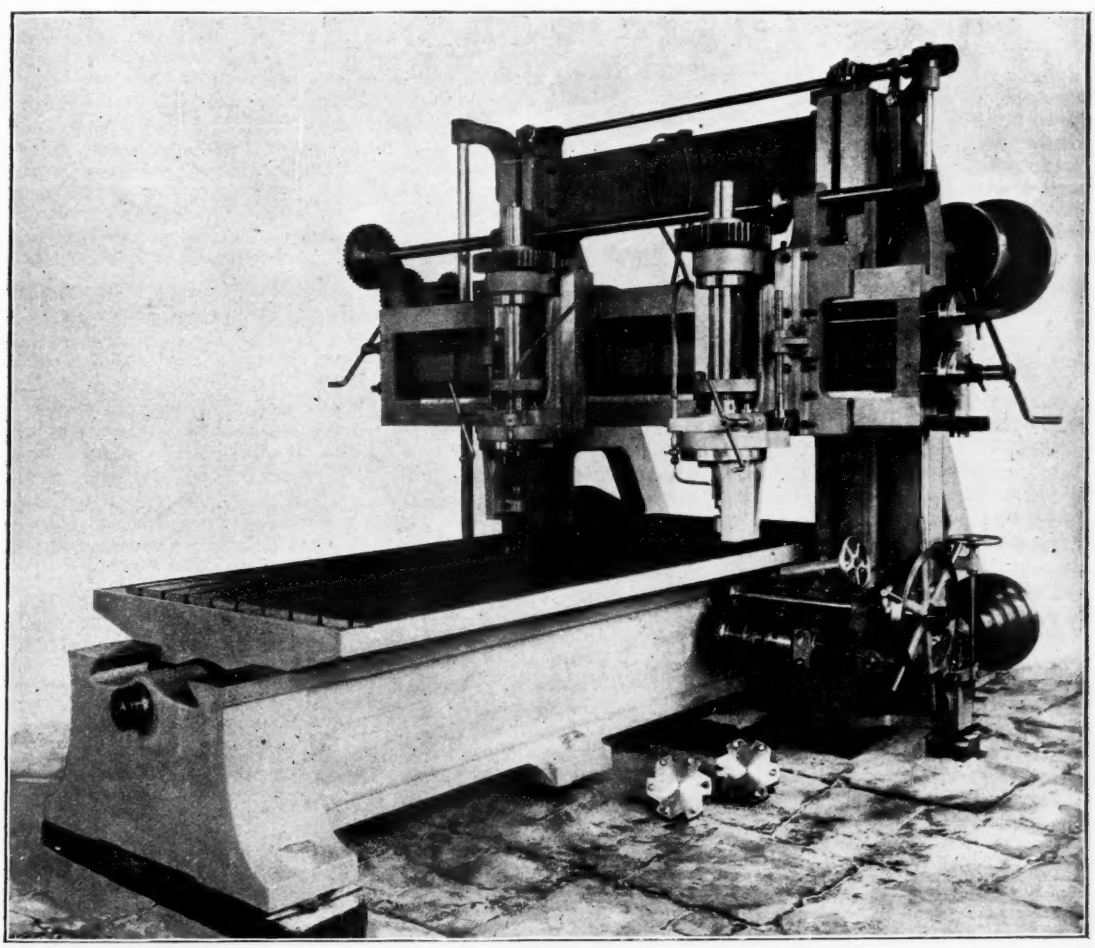
(*Continued on page* 242.)

## ELECTRICAL FACTORIES AND THEIR MACHINERY.

No. II.

It would be impossible to mention in detail the complete equipment of an electrical workshop, but there are still some machines at Messrs. Parker's which merit more than passing mention. In the first article on this subject considerable prominence was given to the views of Mr. Samuel Dixon on the development of the milling machine. We suppose that those in the habit of using machine tools are quite ready to admit that a milled surface requires less working on by hand than a planed surface: indeed, the advocates of the milling machine hold that instead of spending much time adjusting the surfaces of material, the work of the fitter will in the near future be almost entirely confined to setting out work and assembling the parts after they have been finished on the machines.

It would seem that co-operation between users and manufacturers of machine tools has been only brought about within the last few years. Each machine tool maker seemed to be noted for a certain kind of machine, and the worker in metal was compelled to look round in order to see what machine was best adapted for his particular kind of work. At the same time, to arrive at the economical production of machinery, it was necessary that some standard type should be adopted, and hence it is that one sometimes hears of work being modified to fit in with the machine. For instance, one hears that the form of connecting rods for locomotives have been in some cases modified to allow of a complete finish from the milling tools. One of the most useful and interesting machines at Messrs. Parker's is a powerful double-spindle milling machine, constructed by Messrs. Kendall & Gent, Manchester. It is of the "plano," or planing machine type, and is capable of dealing with objects 5 feet wide and 12 feet long. The spindles are very strong, and carried by conical bearings, the lower ones of which have a vertical adjustment for putting on the cut without altering the adjustment of the cross-slide upon the uprights. The uprights are very strong, being specially designed to resist the transverse or side-thrust of the milling cutters. Variable self-acting feed motions are fitted longitudinally to the table, and in the transverse directions along the cross-slide to the milling spindles, enabling a rectangular object to be machined upon five sides without re-setting. It has also quick-power motions in either direction for rapid adjustment. The feed motions are independent of the speed of the spindles, and the exact rate of feed in inches per minute at any moment is indicated by a tabulated index plate, enabling the foreman to see at a glance if the machine is performing its maximum duty. The driving is very powerful, with sufficient range for all required variations in speeds and diameters of cutters, and all the motions are arranged so as to be under the easy and efficient control of the workman.

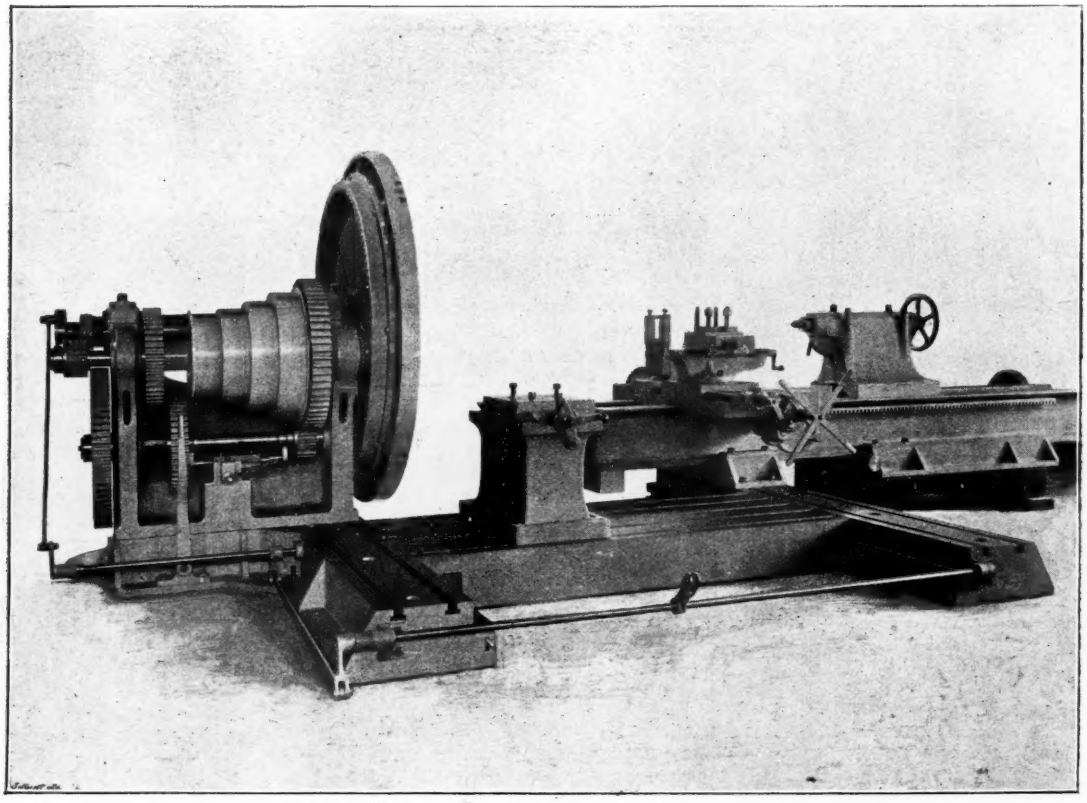


Double Milling Machine at Parker's, Limited (Kendall & Gent).

Perhaps the most striking machine in the main erecting shop is the lathe shown in the illustration, which has been supplied by Messrs. Kendall & Gent, Manchester, and is designed for turning and boring the field magnets and armatures of large multipolar dynamos up to 14 feet diameter. It will admit objects 8 feet wide in the gap, and 20 feet long between centres. The fast headstock has a very strong steel spindle, carrying the large face-plate, which can be driven either single, double, or treble gear, through an internal wheel at the back of the face-plate, giving a graduated series of 24 speeds. The chuck is 8 feet diameter, and is fitted with jaws for holding the work. The bed is adjustable to, and from the face-plate, by rack and pinion, and carries a strong saddle,

provided with self-acting sliding and surfacing motions. The loose headstock is 24 inches, centres from the bed, and is rigidly cramped to the bed by four bolts. For turning large diameters in the gap a stand is provided, carrying a supplementary rest. The lathe is of very solid construction, and is of ample power for taking heavy cuts upon the full diameter.

Leaving the machine tools for a moment, there is little doubt that one of the most generally neglected, and yet one of the most important factors in the efficiency of the modern workshop, is the grindstone, for the output of many of the expensive machines employed depends largely upon the speed and accuracy with which the various cutting tools are ground and sharpened. Messrs. Parkers, Limited, use a grindstone made by Messrs. Kendall & Gent, Manchester, which has been designed for the purpose of enabling the tools for the whole workshop to be ground by one man, who need not be skilled. It is adapted for all kinds of workshop tools, and is fitted with holders for the different forms of cutters. The rectangular traverse bar carrying the tool-holder may be set at any angle, and the tool traversed with a reciprocating motion across the stone. By the use of this apparatus the workmen are provided with a constant supply of ground and sharpened tools, thus saving the whole time which is usually occupied by grinding, during which large and valuable machines are frequently standing idle. The workmen have therefore no necessity to leave their machines for the grinding of tools, &c., a very important consideration in these high pressure days.



Large Boring Lathe at Parker's, Limited (Kendall & Gent).

## THE CABLE SHIP "TUTANEKAI."

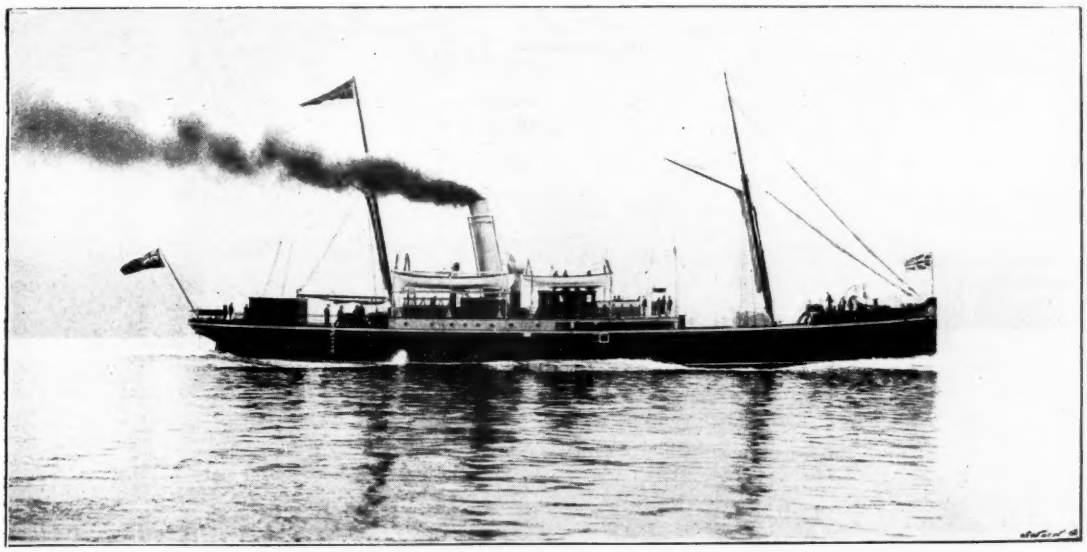
The above-named vessel, which was built for the New Zealand Government by Messrs. Dunlop & Co., of Port Glasgow, is designed for several purposes, the most important of which is the repairing of the New Zealand Government cables, and Messrs. Johnson & Phillips, of Charlton, were entrusted with the complete outfit of apparatus, accessories, and stores for this purpose. A novelty in the design of all the deck cable machinery and fittings is that it can all be easily removed, so that when the ship is not required for cable purposes the whole of it can be taken away and put into store, leaving the decks free. All the holding-down bolt holes are provided with sockets into which plugs can be screwed, so as to leave the deck perfectly watertight when the gear is removed.

The picking-up and paying-out machine is extremely compact, though it is a double machine, and is designed to pick up cables under a strain of 20 tons; it only weighs 9¼ tons, and only occupies a deck space of 8 feet 3 inches × 11 feet 6 inches. It is very similar in design to the gear recently fitted by Messrs. Johnson & Phillips on the Japanese Government steamer, except that it is not quite so powerful and has horizontal engines instead of vertical. The machine is built on two frames made of steel plates, with steel angles inside and outside with welded corners. The drum shaft, which has large collars welded on for attachment to the frame, ties them well at the top. The forward bottom ends are tied by a steel plate and also by a flanged shaft which carries the fleeting knives, and takes the eyes of the main brake straps. There is also a "T" bar stay at the bottom after end, as well as diagonal stays at each end of the pairs frames, thus making a very stiff job, and allowing of the whole of this part of the gear being lifted out in one piece without fear of the shafts or bearings getting out of line. The machine is designed for two speeds, which can be geared on to either drum, but the port drum only is intended for the heavy lift of 20 tons, for which purpose it is built in steel, whereas the starboard drum is of cast iron. These drums are 6 feet 7 inches diameter × 2 feet wide over all. They are internally geared, and have a rim cast on for the main brake, and so combine main drum, brake drum, and gear wheel. The drums are arranged to run loose in the shaft, and are capable of many combinations with the gearing as follows:—Both drums can work loose without the engine. Both drums can work at the same speed with engine. One drum can be driven by engine while the other runs independently. One drum can be held by brake while the other is being worked by engine. Power of both brakes can be put on to one drum by keeping the pinions in gear..

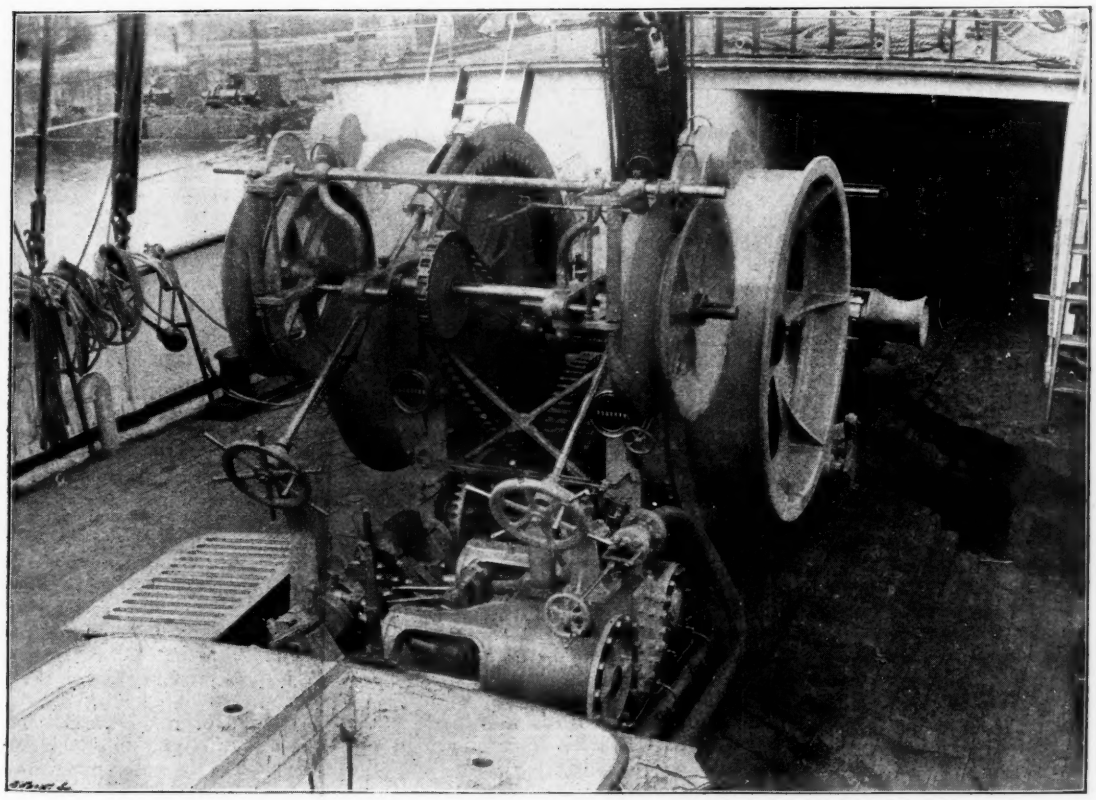
All wheels are arranged to draw out of gear where possible when not required for driving, so as to avoid rattling. In the case of the pinion which gears with large drums this necessitated cutting large holes in the frames, so that the pinion could pass right through them. The frames at these parts are provided with large circular cast iron pockets, which carry bearings at each end, so that when the pinion is in work it is close up to a bearing, thus ensuring a very sound job. The brakes consist of steel straps with elm blocks attached, the ends of the straps being fitted with steel castings which carry nuts with right and left hand threads to take the brake screws. The screws and rods are taken down to the after end of the machine, so as to be worked from the main deck. The lower part of the brake strap is fitted with a large cast-iron eye which transmits the strain to the lower part of the machine frames by means of a steel shaft which is secured to the frames by means of large cast-iron flanges.

Hauling-off gear is driven by chain from intermediate shaft, so that its speed is always proportionate to that of the drums. For holding back purposes the sheaves have a brake rim cast on them, and on these rims a steel strap with screw adjustment is fitted so that the amount of "drag" put on the cable can be adjusted minutely. The sheaves can slide along on their shaft to suit an inside or outside lead.

A small Worthington pump is fixed between the frames to supply the main and holding-back gear brakes.



Cable Ship "Tutanekai."



View of Cable Apparatus on the "Tutanekai."

The engine has cylinders 9 inches and 16 inches × 10 inches stroke, suitable for steam 160 lbs. per square inch, and it is complete with automatic bye-pass valve, steam valve, and link motion reversing gear, all of which, with the main and holding back brakes, are within reach of one man at the after end of the machine. The gear was run under steam pressure at Messrs. Johnson & Phillips's works, and also on board the vessel, to the satisfaction of the consulting engineers, W. H. Preece, Esq., and W. R. Culley, Esq., of H.M.T.S. *Alert*. The bow gear consisted of two steel sheaves 3 feet 2½ inches diameter × 11½ inches wide, which run loose on a steel shaft supported in cast-iron brackets, attached to three steel girders. Each sheave is provided with C I whisker-guards, to prevent the cable getting off the sheave, these guards also being bolted securely to the whiskers. The girders are fitted with eyes and bollards to secure the stoppers. A davit is provided between the sheaves for launching mushrooms, &c., and is arranged to fold down out of the way when necessary to let go the "bight."

The vessel is fitted with the usual dynamometers, lead wheels, deck leads, troughing, &c., and is fully equipped with a complete outfit of stores and accessories, including grapnel and buoy ropes, grapnels, mushrooms, buoys, chains, sounding shot, steam sounding machine, steam hauling gear, &c., and the testing room was provided with a set of first-class instruments.

## THE COX THERMO-ELECTRIC GENERATOR.

Many attempts have been made to reach that El Dorado of the electrician, the direct conversion of the chemical energy of fuel into electric energy. Inventors generally try to attain this end by means of a kind of primary battery, in which carbon or some other form of fuel is the element consumed. Up to the present, the most promising inventions of this kind have come to grief. Within the last two or three years the Borchers, Coehn and Jacques generators have been announced with a flourish of trumpets; but none of them appear to have been of practical value, and hostile criticism appears to have shown that the electric energy which they did produce was not derived directly from the combustion of the fuel element of the battery.

Whether or not we shall ever succeed in obtaining electric energy direct from the chemical energy of fuel, the somewhat less ambitious feat of obtaining electric energy directly from the heat produced by the ordinary combustion of fuel has long been rendered possible to us by the great discovery of Seebeck. But notwithstanding the length of time that has elapsed since Seebeck's discovery, very little success has yet attended the attempts to construct a practical thermo-electric generator.

Markus, in 1865, constructed a thermo-electric couple, the positive element of which consisted of an alloy of 10 parts of copper, six parts of zinc, and six parts of nickel, and the negative element of 12 parts of antimony, five parts of zinc, and one part of bismuth. From each couple he obtained an E.M.F. of ·055 volt. The positive element of this pair fuses at 1,200° C., and the negative element at 600° C. This great difference between the fusibility of the elements of a couple is the cause of one of the great practical difficulties in producing a thermo-electric generator, namely, the difficulty of producing a good joint between the elements of the couple. As we shall see further on, one of the improvements which Mr. Cox has made in the thermo-electric generator consists in overcoming this difficulty.

Clamond was one of the first to devote himself to the construction of thermo-electric generators on a large scale. He constructed a pile of 6,000 couples, from which he obtained an E.M.F. of 218 volts. He found, however, great difficulty in keeping the external junctions cool. He was not able to convert more than 5 per cent. of the heat supplied to the pile into electric energy. These piles of Clamond also underwent rapid deterioration.

One of the most prominent workers in this field at the present day is Mr. Harry Barringer Cox. Mr. Cox is an American, and has devoted the last 20 years of his life to the evolution of a practical thermo-electric generator. After having studied all that was known about thermo-electricity in Germany and France, he returned to the United States, where he has since worked out and patented many improvements in the thermo-electric generator. So tireless and exhaustive have been Mr. Cox's labours in this field, that his patents may be said to contain the history of thermo-electricity for the last 15 years.

A short description of Mr. Cox's latest thermo-electric generator, which was brought out in America about two years ago, has already been given in the Electrical Review, Vol. xxxvi., p. 612. Mr. Cox has now removed his head-quarters to this country, and has just built a fine laboratory at St. Albans, which is to be devoted exclusively to the study and development of thermo-electricity and the design of commercial types of his new generator. We had the pleasure recently of visiting this laboratory and inspecting Mr. Cox's latest achievements in thermo-electricity, and the following account of what we saw will, we think, show that Mr. Cox has produced an invention which may find a limited scope as a generator of electricity.

What Mr. Cox has chiefly aimed at, is to increase the durability of the generator. How well he has succeeded in this may be judged by the fact that he claims to have had some of his generators in use for four or five years without any important falling off in their electromotive force.

In the Cox generator, one element consists of an alloy of antimony and zinc, and the other of copper and nickel. A sufficient number of couples to form one ring or tier in the generator are cast together in a mould of peculiar construction. The mould is made in two halves, A and B, fig. 1, each half being a steel plate with pointed teeth on one of its edges.

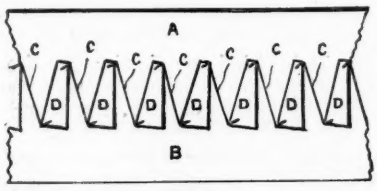



Fig. 1.

When the two halves of the mould are placed together, the teeth intermesh as in toothed gearing, and grip the short copper plates, C, which form the positive elements between their bearing surfaces. The clearance left between the back of one tooth and the face of the tooth next following, forms the moulds or cavities, D, into which the antimony alloy forming the negative element, is cast. The ends of each copper element are bent round so as to lie across the ends of the cavities into which the antimony alloy is poured.

The fused antimony thus comes directly in contact with the copper plates, but this would not be sufficient to make a good joint if the metal were allowed to cool in the ordinary way. Since the fusing temperature of the antimony alloy is about 300° and of the copper 1,000°, a strong welded or alloyed joint could evidently not be secured at the lowest fusion temperature.

Mr. Cox, in the course of his researches on the thermo-generator, found that one of the chief deleterious effects came from the imperfect junction of the elements, and he believes he has succeeded in overcoming this difficulty, and produced a true welded joint between the antimony and the copper by heating the steel moulds to a high temperature before casting, and maintaining them at this temperature for a considerable time thereafter. A gradual process of alloying thus takes place between the fused antimony and the copper at their surfaces of contact. A certain percentage of copper penetrates into the antimony, and a certain percentage of antimony into the copper. The stratum of metal which forms the junction of the two elements will vary uniformly in composition from that of the positive element at one side to that of the negative element at the other side. Mr. Cox considers that this circumstance has a good deal to do with the more efficient action of his thermo-electric couple.

The series of couples cast in one piece at each casting is bent round to form one ring or tier of the thermopile. Before this, however, each piece is carefully annealed, till the antimony alloy which, before annealing, could be easily broken by the fingers, becomes quite tough.

After annealing, each piece, containing the same number

of couples, is tested for resistance, to discover whether the joints are good, and whether the annealing has been thoroughly carried out. If the resistance of any piece deviates from the standard by a small fraction it is rejected, this deviation being taken as evidence of an imperfect joint, or some other mechanical imperfection. In fig. 2 a pile of the couples ready for having their resistance tested may be seen piled up on a bench in the casting room.

Each length of couples is now bent into a ring, and a sufficient number of these rings are piled one on the top of another to form a pile of cylindrical shape.

Each cylinder is 7 inches in diameter, by 5 inches high. Each ring or tier of couples contains 15 couples, and, when heated by a Bunsen flame, gives an E.M.F. of 1·2 volts and a current of 4 amperes.

It is not clear to us, however whether this voltage is on closed or open circuit; if on open circuit it is naturally much lower than 1·2 volts when a current of 4 amperes is passing. After a sufficient number of rings has been built up to form a pile, and all connections made, the whole is coated with a layer of glassy enamel. This preserves the couples completely from the corrosive and disintegrating action of the hot gases of the gas flame, and gives to the Cox generator its greater durability.

A tank or hollow casing is fixed round the outside of the cylinder in as perfect mechanical contact with the couples as possible, but at the same time thoroughly insulated from them by means of the enamel above referred to, and water circulating through this tank or casing keeps the outer ends of the couples cool. This casing may be small where the means of producing a constant circulation of water are available. Where that is not the case, a slightly larger tank is used; and recently Mr. Cox has made experiments with this type of generator, which show that the necessary cooling effect can be obtained with a tank of very moderate size.

The laboratory which has been designed and recently completed by Mr. Cox, is probably the largest and most complete establishment in existence, devoted solely to thermo-electric investigation. In the large central room is a stamping machine for stamping out the copper strips, which form one element of the couples, and a turning lathe, both being driven by an electromotor.

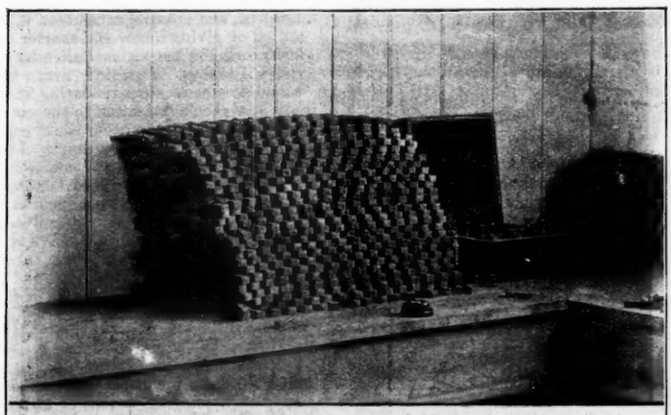
In an underground chamber, beneath the floor of the large central room, is a large storage battery capable of giving current at 112 volts. By means of a special switch the cells of the storage battery can be rearranged, so as to reduce the charging E.M.F. to such a point that the cells may be charged by one of the Cox generators. In this way Mr. Cox stores all waste electric energy developed during testing and such like operations.

Besides the casting room, and large central room already referred to, there is a private testing room supplied with a complete outfit of the latest testing instruments from France, England, Germany, U.S., &c.

Mr. Cox showed us a large generator 3 feet in height, and 18 inches in diameter, which, he said, had been in continuous use for four or five years. Its output was stated to be 400 watts, namely, 10 amperes at 40 volts.

The battery of four generators, fig. 3, has been fitted up as a type of what will be suitable for lighting a moderately-sized house. Of course these batteries can be set up in pairs —three, four, or any number—depending upon the amount of work required of them. It consists of four cylindrical generators, each 7 inches in diameter, and 5 inches in height. Each generator is capable, it is claimed, of producing a current of 2 amperes at an E.M.F. of 12 volts. The four generators, therefore, when connected in series, should develop 2 amperes at 48 volts, but here again arises the uncertainty as to whether the volts given were obtained on open circuit. Below the battery of generators is a battery of storage cells, which is connected up in parallel with the thermo-generators.

Fig. 2.



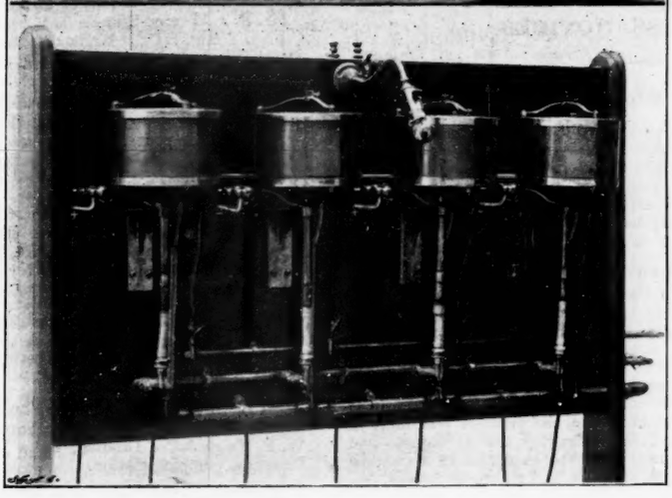


Fig. 3.

Each generator is excited by a Bunsen flame, which rises through the central aperture, and is deflected towards its sides by a series of metal discs which increase in diameter from the bottom towards the top. The sides of this aperture or funnel are, like the rest of the apparatus, coated with enamel; the heat reaching the inner joints of the couples through this layer of enamel.

Gas experts have given Mr. Cox, as the result of their measurements, 2½ cubic feet per hour as the consumption of a battery of this size, but we can only conclude that the meter used by the experts must have been very much at fault. The battery is kept going continuously, and while the current is not required for lighting or other purposes, it is stored in the storage battery.

It is interesting to compare the E.M.Fs. of the couples of Markus, Clamond and Cox. These are taken from figures given without qualification of temperatures, and are presumably the maxima producible under working conditions. They are as follows:—

| | |
|---|---|
| Markus ... ... ... | ·05 volt. |
| Clamond ... ... ... | ·036 volt. |
| Cox ... ... ... ... | ·08 volt. |

Mr. Cox appears by his improved joint to have obtained 60 per cent. more E.M.F. from his couple than Markus, and a still greater increase on that of Clamond. The metals used in Markus's couple were not very different from those in Cox's couple, so that the improvement must be entirely due to the welded joint produced by the latter. Of course, the Cox joint has another advantage in having a much lower resistance than the joints of previous thermo-electric

generators, a fact which still further increases the amperage obtainable under like conditions.

Mr. Cox's experiments have led him to the somewhat heteredox conclusion that the temperature of the external ends of the thermo-electric couples may be varied within considerable limits without producing any important change in the E.M.F. But the outcome of the labours of practical men have before now led to the revision of theoretical conclusions.

The Cox generator, we are informed, has already been successfully applied to telegraphy, and ten lines of a telegraph company in the U.S. were operated for a period of two months, at less than one-eighth of the usual cost, but there is probably some error here. We believe that these generators are also being tried by the Postal authorities in this country.

There can be little doubt that the Cox generators may prove serviceable in certain applications, even though the cost of thermo-generators should be much greater than that which may be worked out from Mr. Cox's figures, concerning which, by the way, we disclaim all responsibility. Their durability, constancy of E.M.F., freedom from general messiness, and comparative independence of skilled attention, must make them useful in cases where small installations are required. For installations in country houses, and other residences not within the reach of a central station, this thermo-electric generator promises to be superior to anything of its kind hitherto proposed. We wish Mr. Cox success in the development of his invention, and if in practical working he succeeds in realising the results of laboratory tests, he will be looked upon as a benefactor by consumers of electricity, but until figures are forthcoming based upon undoubted authority, we must reluctantly conclude that the development of electrical energy by Mr. Cox's method will be found somewhat expensive.

## BUSINESS NOTICES.

(*Continued from page* 236.)

**Burglary.**—Thieves succeeded in entering the premises of Messrs. Gullette & Co., electrical instrument manufacturers, Cow Cross Street, E.C., between mid-day of Saturday last and Monday morning, and clearing away a quantity of cabinet makers' and other tools of various kinds. Fortunately the office and stores were well secured, and resisted the burglars' efforts at entrance, and very little damage was done to work in hand.

**Business Announcement.**—Messrs. Nalder Bros. & Co. inform us that on account of the increase in their ammeters and voltmeters, that portion will in future be carried on at 34, Queen Street, by one of their partners, Mr. F. H. Nalder, in conjunction with Mr. E. Thompson, for some years manager of their ammeter test room. The style of the new firm will be Nalder Bros. and Thompson, to whom all communications on the subject of electric light apparatus should be addressed. The constitution of the firm of Nalder Bros. & Co. is, however, unaltered, the partners remaining as before—Messrs. F. H. Nalder, C. W. S. Crawley, and A. Soames—and it will retain the whole business with the exception of ammeters, voltmeters, wattmeters, cut-outs, switches, and resistance frames.

**Calcium Carbide.**—Most of our readers will have followed our notices from time to time regarding calcium carbide and acetylene, and the following information given to us by the company referred to will be read with interest:—The Acetylene Illuminating Company, Limited, of 63, Queen Victoria Street, London, have concluded arrangements with the British Aluminium Company, Limited, by which they will be able to erect works of several thousand horse-power for the manufacture of calcium carbide—using water-power. Pending the construction of such works, the Acetylene Company have obtained the use of a considerable portion of the spare water-power of the existing works of the British Aluminium Company at Foyers, and a carbide plant is now being erected there, which it is expected will be in full work during the month of October next. It appears that the Acetylene Company have been making calcium carbide in this country on a fairly large experimental scale since the early part of 1895, but, as so much had to be learnt in the details of manufacture and as to the behaviour of acetylene gas under various conditions, they have not until now felt justified in erecting large works. Having now succeeded in regularly making a crystalline metallic carbide free from dangerous impurities (such as exist in some specimens of foreign carbide which found their way to this country), and having satisfied themselves as to the gas being no more poisonous than coal gas—in fact, less so—and that there is no danger of explosive compounds being formed in contact with metals, they have decided to go ahead with the manufacture on a large scale with water-power. The Acetylene Company holds an exclusive license for the United Kingdom, under the "Willson" patents, for the manufacture of calcium carbide, and also an exclusive license under numerous patents controlled by the British Aluminium Company.

The Prussian State Railway Authorities in Berlin are inviting tenders until September 1st, for the supply of 60 tons of calcium carbide. Tenders to be sent to the Königliche Eisenbahn Direction, Berlin, Schöneberger Ufer, No. 1 Berlin. Here is a chance for the company mentioned above.

**American Catalogues.**—We have received a catalogue of the James Leffel water wheels, standards, specials and Samsons built by Messrs. James Leffel and Co., of Springfield, Ohio, U.S.A.; also one by the same firm dealing with the Cascade water wheel as made by them. From Rousseau's Electrical Works of New York we have also received a list of general electrical supplies, and a catalogue of the manufactures of James F. Burns's Steel Works of Schenectady, N.Y., which gives illustrations of telephonic and graphophone apparatus, also electro-medical apparatus, &c.

Another American catalogue that we have received this week comes from the Royal Electric Company of Peroia, Ill., and is devoted to electrical machinery (alternate and continuous) for light and power, chiefly dynamos, exciters, transformers, motors.

**Callender's Company.**—Increase of business in several directions, including electric tramway work, has necessitated the reconstruction of Callender's Bitumen and Waterproof Company, Limited, and advantage has been taken of the opportunity thus presented of giving a new and shorter name to the company, which will henceforth be known as Callender's Cable and Construction Company, Limited, of which, may we suggest, that C. C. & C. C. would be a convenient rendering in these busy times. The company will give special attention to the construction of every class of railway, tramway and lighting work, and what is a very essential point with such a company, has ample capital and powers. The business of the old company has, of course, been taken over; but no alteration has been made in the directorate management or general staff, except that Mr. T. O. Callender will have a seat on the new board as managing director. All the old company's liabilities will be discharged by the C. C. & C. C. We understand that the whole of the new company's capital has been taken by the old shareholders, and the debenture stock recently offered has been largely oversubscribed. Mr. Spencer C. Lambert acts as secretary.

**Changes of Addresses.**—Mr. J. S. Cunnington, electrical engineer, has removed from 5, John Street, Adelphi, to larger premises at 18, Cecil Court, Charing Cross Road, W.C. He has there fitted up show rooms for electric light fittings, which business he will carry on in addition to that of an electric light contractor.

Mr. F. J. Warden-Stevens has removed from Martin's Chambers, Cannon Street, E.C., to larger offices at Connaught Mansions, Victoria Street, Westminster, S.W. His country address will still be Town Hall Chambers, Guildford.

**Electric Bell Indicator.**—A novel, but exceedingly simple, arrangement for denoting whether electric bells have rung or are in proper ringing order is being made by Mr. J. W. Creasey, of Kingston. It consists of a new indicating bell push, which when the bell rings at the other end, tells the operator so by means of an oscillating indicator placed just above the push button. This indicator is actuated by the same current that rings the bell. There have been other means devised for seeing whether a bell rings, but this device is a very neat one, and there should be a considerable demand for it.

**Electrical Trades Union.**—Mr. Sims, the general secretary of this Union, informs us that the members are holding a meeting for organising purposes on Monday next, the 24th inst., chair to be taken at 8.30 p.m. The meeting is open to all workers in the trade.

**McDougall's Stokers.**—The London County Council has selected McDougall's patent mechanical stoker, as made by Messrs. W. B. Haigh & Co., Limited, for a large installation of boilers for Crossness pumping station.

**Outing.**—The employees of Nalder and Hilton had their annual outing on August 1st. The party, numbering between 50 and 60, proceeded to Hastings, where a most enjoyable day was spent.

## ELECTRIC LIGHTING NOTES.

**Ashton.**—The Council intends lighting the borough electrically on the low tension system. The site for the station is situated in Town's Yard. It is also understood that the Council will supply current for the local tramways to the company which owns the lines.

**Bexhill.**—Lord De la Warr has made a proposal to lay down an electric light installation for the district, but the Council are considering whether they shall do it themselves. The matter stands referred back to the Committee.

**Bedford.**—A correspondent of the *Bedford Times* asserts that the electric light machinery at the central station causes considerable annoyance in the Prebend Street district. He blames the vibration and noise thus caused for making people remove from the neighbourhood, and calls upon the Town Council to do something immediately to avert the depreciation of the property in the district.

**Belfast.**—Mains are to be extended down Wellington Place and Donegall Square North.

**Bolton.**—In the annual statement of accounts just issued by the Borough Treasurer (Mr. G. Swainson), particulars are given as to the financial position of the electric light undertaking. The sale of electric current for the 12 months yielded £2,077, and the fittings department showed a profit of £328. On the other hand, the generation of electricity cost £1,081, distribution £29, rents, rates, and taxes £184, management expenses £263, miscellaneous £98, interest charges £1,014, and repayment of loans £835. From scanning the capital account, the Borough Surveyor fears that unless the public more extensively avail themselves of the new light, the account will continue to show a loss, unless the surplus day supply is utilised for the working of the town and suburban tramways. He points out that the plant laid down could supply many times the present demand for the current.

**Bradford.**—Progress is being made with the street lighting arrangements. Arc lamp standards are now being erected in the neighbourhood of the Town Hall.

**Coventry.**—The Technical Institute is being fitted up for electric lighting.

**Colchester.**—The Town Council has appointed, temporarily, a canvasser in connection with the electric lighting scheme.

**Crediton.**—The Gas Company having refused to meet the District Council regarding the gas supply, a price is to be obtained for electric lighting.

**Church Lighting.**—The contract for lighting St. Saviour's Church, Southwark, with 350 16-C.P. lamps has been secured by Messrs. Richard Crittall & Co.

**Canterbury.**—Last week the plans and estimates of Mr. Robert Hammond, *re* electric lighting and dust destructor scheme, were considered by the Town Council. Several speakers opposed the idea of the dust destructor, and eventually the whole question was referred back to the Lighting Committee.

**Douglas (I.O.M.).**—The Town Council considered the lighting question again last week, when a proposal for incandescent lighting was before it. It was contended by some that the town should be lighted electrically, and that a company was in existence which could supply the light on favourable terms, but others argued that the town should have its own installation. After discussion, it was decided that the question be reconsidered before any system is selected.

**Eccles.**—The Local Government Board has declined to sanction borrowing powers for £20,000, to enable the Town Council to carry out its electric lighting scheme. It will be remembered that the scheme was the subject of much opposition at the Council meetings, and was only carried by the casting vote of the Mayor. Since then two members have been elected to oppose the scheme, so that there is a majority of dissentients now on the Council.

**Glasgow.**—We understand that the annual statement issued on Monday by the Electric Lighting Committee shows that, after meeting all expenses, there is a surplus on the year's operation of £2,400. They recommend the abolition of meter rents, special rates for large consumers, and that the charges for street lamps be reduced from £26 to £20 per annum.

**Hampstead.**—The *Express* states that the demand for current is still on the increase. The equivalent of 8 C.P. lamps being supplied from the station on August 3rd was 29,000. It is understood that if the present rate of increase continues, the whole of the available plant will be in full use by the end of the autumn. A commencement has been made with the buildings for the extensions.

**Hull.**—We are pleased to see that the extensions scheme is not abandoned. The Electric Light Committee considered the matter again last week, and the engineer thought that with a view of getting the scheme, or some other scheme carried through, it would be advisable that the advice of a consulting engineer should be obtained. The Committee re-affirmed their conviction that it was necessary to provide additional generating plant, and provide for extending the mains over all parts of the borough, and also resolved that a consulting electrical engineer be engaged to advise and report to the committee as to the best means of extending the supply.

**Handsworth.**—It is proposed to light the new Technical School, the Council premises, and the Public Library, by electricity.

**Hunstanton.**—For the present the electric lighting question is shelved, so far as the District Council is concerned.

**Ipswich.**—At the last Council meeting, the Electric Lighting Committee submitted reports by themselves and Prof. Kennedy on proposals to light defined areas by means of electricity.

**Lancaster.**—The Corporation wants a dynamo and switchboard attendant at the electricity works. For further details see our "Official Notices."

**Liverpool.**—The Lighting Committee and the electrical engineer (Mr. Holmes) recommend the reduction of meter rents from 2s. to 1s. per month, and that on and after October 1st, the charge for current for lighting purposes be 7d. per unit instead of 7½d., with a specially reduced rate for large consumers, the charge for current for motive power purposes being 4d. instead of 5d. per unit.

There has been referred to the City Electrical Engineer an official request for a scheme and an estimate of lighting St. John's Market with electricity, and a separate estimate for lighting the market shops with the same illuminant.

**Middlesbrough.**—The Town Council has shelved the question of providing an electric lighting installation until after the November elections.

**Omagh.**—The Board of Control of the Omagh District Lunatic Asylum is recommended by a committee to lay down larger boilers than originally intended, in case electric lighting should be introduced later on.

**Reigate.**—A discussion is going on here *re* the electric lighting scheme proposed by Mr. Medhurst, who says that the low tension system is absolutely out of the question for the town.

**Stafford.**—The Gas and Electricity Committee reports that the application of the Westinghouse Company for a renewal of the three-wire patent having failed, the Council, which formerly was liable to pay a royalty of 50s. a ton on the 40 tons of cable laid in the town, will now have to pay nothing.

**St. Helen's.**—Things are now in a forward state in connection with the electric lighting, and in a few weeks the centre of the town will be supplied with current.

**Sheffield.**—Several new buildings in High Street including the Grand Clothing Hall, are to be lighted by electricity, and the Electric Light and Power Company is busy with the wiring and fitting work.

**Stowmarket.**—We learn that the electric light is steadily gaining ground here. Mr. A. Chapman has had his premises lighted inside by incandescents and outside by arc lamps.

**Spain.**—A contract has lately been placed for the establishment of a central station at Tarrasa. The dynamos will be driven by three 100 H.P. Crossley gas engines.

**Southampton.**—The Town Council has decided to purchase additional land for the electric lighting works for the sum of £5,300. Application is to be made to the Local Government Board for sanction to borrow the amount for 50 years, in addition to the sum of £50,000 in connection with the electric light undertaking.

**Walsall.**—The Electric Lighting Committee reports that the total number of consumers supplied on July 31st last was 63. The total units generated at the station during the month of July was 5,748. The total output from the main generators was 5,395 units. The wages paid during the month amount to £31. The value of coal consumed was £12. The Committee has accepted the tender of the Babcock & Wilcox Company for supplying one of their water-tube boilers for the electricity station in Wolverhampton Street for the sum of £486 10s.

**Withington.**—The residents are to be circularised as to whether they are favourably disposed towards the electric lighting scheme.

## ELECTRIC TRACTION AND MOTIVE POWER NOTES.

**Brighton—Rottingdean.**—We learn that the car for this seashore electric railway is now erected, and the machinery all fixed. The remainder of the overhead wire is now being erected, and after inspection by the Board of Trade, the line will be opened for traffic. Very little now remains to be done. The machinery at Rottingdean Pier is fixed and ready to start.

**Bristol.—Very Satisfactory Results.**—The remarks of Mr. Butler, the chairman of the Bristol Tramways and Carriage Company, at the meeting held on 6th inst. at Bristol, very naturally dealt chiefly with electric traction, especially in reference to the Kingswood section, which, he stated, gave such satisfaction that anxious enquiries were coming in from every district of the city and suburbs for an extension of the electric traction system. The board were quite prepared to extend electric traction throughout the entire system, so satisfied were they that it in every way meets the public requirements. He further said that they were at the moment preparing a scheme not only for the extension of electric traction over the other portions of their own system, but also for the extension of the lines into other districts. Whether or not the scheme could be all carried out depended very much on the Corporation of Bristol. An extraordinary meeting was afterwards held, at which the capital of the company was increased by £250,000.

**Cork.**—From an "Official Notice" in this issue, it will be seen that the Tramway Company will want a supply of electric current from the company, to whom the Corporation transfers the provisional order, for the purpose of working their tramways.

**Douglas Southern Electric Tramway.**—This tramway, which runs on the overhead trolley system, is now in working order as far as Whing Line, and up to this point has been thoroughly tested by Col. Rich and pronounced satisfactory.

**Italy.**—Two thousand proprietors of public vehicles held a meeting in Rome, on Monday morning, in order to protest against the introduction of electric tramways. The proceedings were attended with a good deal of disorder, and at one time it looked as if the crowd and the large force of police and carbineers on the spot would come into collision. We should hardly think a meeting of hot-headed interested parties can have any effect upon the adoption of the scheme. The shareholders in a gas company could not alone prevent an electric light installation being put down, at any rate not in this country.

**Italy.**—The Municipal authorities of Turin have placed a contract with a Belgium Company for the conversion of several of the tramways in the town into electric lines.

**London.**—The tenth annual report (1895-6) of the Hammersmith Vestry is before us. It contains full details of the steps taken during the year in regard to electric lighting, the acceptance of tenders, &c., but a more interesting note is that regarding the proposal of the London United Tramways Company to convert their tramways in the Uxbridge Road from horse traction to the overhead electric trolley system. The circumstances connected with the matter will still be in the minds of our readers. It will be remembered that the company secured the permission of the Hammersmith Vestry to effect this conversion, but the London County Council afterwards overruled the decision, and declined to allow the company to carry out its wishes. The company has made application to the Board of Trade, under whose consideration the matter is at the moment.

**South America.**—A financial contemporary says that a project has been presented to the Monte Video municipality for an electric tramway from that city to Colon, along the new high road lately constructed.

**Sutton-in-Ashfield.**—The District Council have informed Messrs. Meggitt & Sons, Limited, that they are prepared to entertain their application for an overhead tramway across Hamilton Road, provided that the plans are approved by the surveyor.

**Stretford to Peel Causeway.**—A syndicate is seeking powers for laying down a system of tramways along the main road from Stretford to Peel Causeway, and working the same electrically. Messrs. Andrews and Butterworth, surveyors, of Manchester, recently wrote to the Ashton-on-Mersey District Council on behalf of the syndicate. It is said that the tramway scheme would be worked in conjunction with the proposed electric lighting scheme, either by the same company (the Altrincham Electric Supply Company), or by means of an arrangement for supplying power. The Council has acknowledged the letter, but will take no further action.

**The Mumbles Railway.**—Following the offer from a powerful syndicate to acquire on terms which could not be entertained the Mumbles Railway, and to adopt electricity as the motor power, we learn from a Cardiff paper that a fresh offer has been received from the same syndicate which embraces terms that have led the chairman of the Mumbles Railway Company to have conferences with the syndicate. The negotiations have now reached a phase which makes business not unlikely, but owing to the absence abroad of one of the leading members of the syndicate, nothing definite can be settled till November.

**Trolley Wires Essential to the Public Service.**—If one might judge from some of the inane remarks uttered recently before the Tramways Institute by the opponents of electric traction, the great American public has become heartily sick of trolley wires, and will have no more of them at any price. As a small piece of confirmatory evidence to which they are welcome, we present these opponents with an item of news, to the effect that Mrs. Emily W. Roebling, of Trenton, New Jersey, is fighting the local authority as well as the tramway company, for the removal of two poles carrying trolley wires in front of her house. We cannot quite understand the enmity against wires of anyone bearing the name of Roebling, but this is by the way. What is of more importance is the fact that both in the State Supreme Court and the Court of Appeal, the position of the tramway company and local authority has been fully and absolutely upheld, in such terms, too, as will appear very striking to an impartial observer. The essence of the case lies in a single sentence. The prosecutrix owns property on a certain street through which runs the trolley line, and her title extends to the middle line of the street, *subject to an easement in the public for the purpose of a public highway*. Numberless actions have been brought in the American courts to decide various questions arising from this right of public easement, but in regard to electric tramways it is held very clearly and plainly that such rights are entirely consistent with the primary use of the highway, and are no detriment to the land owner. In the case under review, the Court states distinctly that "the erection of poles with wires strung thereon, in the present state of the science, is necessary to accomplish the purposes contemplated," *i.e.*, the transmission of passengers with increased speed and greater comfort as a great public benefit. No compensation is, at any rate, payable, nor previous consent of the frontagers necessary, either on account of the erection of poles and wires, or the actual operation of the tramway, possible damage due to vibration being a distinct matter if caused by unjustifiable means. The importance of this judgment becomes greater when the Court states distinctly that "it is not every use of a public street that is lawful as against the rights of the fee-owner, though such use may promote public benefit." That the use of public streets by electric trolley lines is considered wholly lawful in regard to the frontagers shows very clearly the high esteem in which such lines are generally held by American authorities.

**The Paris Tramways.**—It is not at all unlikely that the approaching sale of the Continental Metropolitan Company's lines in Paris to the French interests now in treaty for them, will effect a considerable change in Parisian traction methods, although the statement has been made again and again that overhead wires will never be tolerated in the French capital. Even municipal authorities have been known before now to change their minds, though the process takes a long time; but those who live longest will see most. As with most other enormously large cities—London, Berlin, Vienna, New York—the tramway problem in Paris must inevitably require many years for a settlement at all adequate to public needs, and meanwhile the city will be a happy hunting ground for accumulator cars, steam traction, compressed air, and complicated conduit systems. An illustrated description of the Serpollet steam motor cars employed on some of the Paris tramways appears in the last number of the *Street Railway Review*; one has to go from home to learn news, though perhaps to most of our readers the Serpollet motor, with its curiously shaped boiler, will not be altogether novel. Chain driving gear is employed between the engine crank shaft and the car axles; this, of course, allows considerable flexibility, but must increase the noise and wear of working. The general conclusion that one is tempted to form with regard to these motors, and the other types mentioned above, is that (quoting Lincoln), "for those who like this sort of thing, we should say they would be just the sort of thing they would like."

**The Horseless Carriage Bill.**—Sir David Salomons, who has been so prominently connected with the horseless carriage movement since its commencement, has written (as president of the Self-Propelled Traffic Association) to the daily press expressing great satisfaction that the "Locomotive on Highways Bill, 1896," has now, after a long period of labour, become an Act. Sir David considers that at no period in the history of the English legislature has so liberal a measure been passed, and pays a tribute to Mr. Chaplin and the officials connected with the Local Government Board and the Home Office, for having accepted the various points which he advocated in person, and in writing, as well as the amendments which were finally accepted in committee on Mr. Chaplin's recommendation, and those which were not opposed by him in committee. The object of the latter is stated to be "on the one hand to express the gratitude of all those I represent in this movement to the Government, to the permanent officials of the departments concerned, and to all others by whose labours and influence success has been obtained; and, on the other, to appeal to every one interested in the movement, whether as manufacturers or users of motors, to do nothing on their part to abuse the freedom which has now been extended to them. It behoves everyone concerned to act with prudence and consideration; to avoid injury to the roads, to use every possible care not to frighten horses, to store no dangerous liquids thoughtlessly, which might endanger life or property, and to act generally with such discretion that it shall not be said, in a year or two hence, another Act must be passed to control those who have shown their inability to control themselves or misused their privileges. There cannot be the slightest doubt in the mind of any reasonable man that this Act will be productive of great changes, and that if all those who have an interest in modern progress will strive to improve self-propelled traffic, and those who avail themselves of its benefits will act fairly towards others having no direct interest in the movement, it will be giving the English nation an advantage which can hardly be overrated, and without entailing, as I hope and believe, a vestige of discomfort or annoyance on any individual." It is quite necessary that words of warning on the subject should be given out, and the present is perhaps a fitting moment for such caution, for if the painful and disastrous occurrence of Monday last at the Crystal Palace autor-car show is repeated these public exhibitions of what horseless carriages can do are likely to do more harm than good. Only men of matured experience in controlling such vehicles should be allowed to drive them, and special instructions should be given regarding careful management.

## TELEGRAPH AND TELEPHONE NOTES.

### Telegraphic Interruptions and Repairs:—

| Cables. | Down. | Repaired. |
|---|---|---|
| Brest-St. Pierre (1869, Anglo) | April 6th, 1895 ... | ... |
| Puerto Plata-Martinique ... | Dec. 19th, 1895 ... | ... |
| Monte Alegre-Santarem ... | May 5th, 1896 ... | ... |
| Para-Maranham ... ... | Aug. 6th, 1896 ... | ... |
| **Landlines.** | | |
| Trans-Continental line beyond Masol (Mashonaland) | March 12th, 1896 ... | ... |
| Communication with Cartagena and Barranquilla, Columbia. | July 4th, 1896 ... | ... |
| Salisbury-Umtali (cutting off communication with Beira) | July 10th, 1896 ... | ... |
| Siberian lines, Radde-Khabarowska ... ... | Aug. 5th, 1896 ... | August 13th, 1896 |
| Khabarowska-Vladivostock... | Aug. 12th, 1896 ... | August 13th, 1896 |
| Tomsk-Kranoiarsk ... ... | Aug. 13th, 1896 ... | August 14th, 1896 |
| Ecuador landlines between Guayaquil, Quito, Cuerea, Machela, Santa Rosa Camar, Azoguez, Saraquro, and Zaruma ... | Aug. 14th, 1896 ... | ... |

**Chichester.**—Messrs. Richard Crittall and Co. have secured the contract for telephones, fire alarms, and attendants' recording apparatus at the West Sussex Asylum, Chichester.

**Telegraphs in Turkey.**—The authorities of the Turkish posts and telegraphs are at present engaged in the preparation of a map of the telegraphic system of the country.

## CONTRACTS OPEN AND CLOSED.

### OPEN.

**Belgium.**—September 15th. Plans and tenders are being invited by the Municipal Authorities of Spa, for the lighting of the public streets by electricity, or by acetylene. Tenders and schemes are to be submitted to the Collége des Bourgmestre et Echevins, Spa.

**Cadiz.**—September 15th. The Secretary of State for Foreign Affairs has received despatches from Her Majesty's Consul at Cadiz, stating that preliminary tenders for a supply of electric lighting apparatus for the illumination, on the most approved modern plan, of the private houses, &c., in the town of Cadiz, are invited by the "Sociedad Co-operativa Gaditano de Fabricacion de Gas." Tenders should be sent in by September 15th, to the above-named company, whose offices are San José, 25, 27, and 29, Cadiz. Firms wishing to obtain the contract for the supply of plant are advised by the Consul to send representatives to treat personally with the company. Such additional particulars as have reached Her Majesty's Government on the subject, may be viewed at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

**Cork.**—September 11th. From our "Official Notices" it will be seen that the Corporation invites tenders from persons who are willing to carry the 1896 electric light provisional order into effect. The company securing the powers will have to supply current to the tramway company for working the tramways electrically. For further details see our "Official Notices."

**Denmark.**—August 22nd. Tenders are being invited by the Lighting Committee of the Municipal Council of Copenhagen, for the supply of 20,000 incandescent lamps. Tenders to be addressed to the Directeuren for Belysning, Svalsen, Copenhagen.

**Dewsbury.**—August 22nd. The governors of the Dewsbury and District Technical School, invite tenders for the wiring and fitting of their premises. Plans may be seen at the office of the Secretary, from whom any further information can be obtained.

**Edinburgh.**—August 27th. The City Council wants tenders for supplying and erecting at the electric supply station, Torphichen Street: (1) coal hoist, gantry, and capstan; (2) coal hoppers, measuring gear, and shoots; and (3) hauling gear in coal store, for the Lord Provost, Magistrates, and Council. Specifications, drawings, and forms of tender can be obtained at the office of the resident electrical engineer, 5, Dewar Place, Edinburgh, on depositing a sum of £2 2s.

**France.**—September 8th. Tenders wanted for the supply of a quantity of alternating current electro-magnetic calls. Tenders to be sent to the Direction Générale des Postes et des Telegraphes, 103, Rue de Grenelle, Paris.

**Glasgow.**—August 28th. The Corporation wants tenders for the electric lighting of the St. Andrew's Halls. Particulars of specification, &c., from Mr. William Arnot, electrical engineer, 75, Waterloo Street, Glasgow. For the full announcement see our "Official Notices."

**Holland.**—August 26th. Tenders are being invited by the Dutch Minister of the Colonies at the Hague, for the supply of a quantity of galvanised iron wire, iron telegraph posts, and insulator supports &c.

**London, S.W.**—August 26th. Tenders are invited for the execution of pneumatic and electric bellhangers' work for public buildings, &c., in the London district for three years from October 1st, 1896, for the Commissioners of Her Majesty's Works, &c. A printed schedule, with a form of tender, may be obtained at Her Majesty's Office of Works, 12, Whitehall Place, between 11 a.m. and 5 p.m. upon payment of 5s.

**Madras.**—Nov. 11th. Lieut. Col. C. C. Rawson (in charge Consulting Architects' Division) invites tenders for the lighting by electricity of Government House, Madras, including the banqueting hall and the A.D.C.'s bungalow: also for the lighting of Government House, Guindy, including the Military Secretary's bungalow. Particulars to be obtained on application to the Consulting Architect to the Government of Madras, Chepauk, Madras.

**Madrid.**—October 8th. The Secretary of State for Foreign Affairs learns from her Majesty's Ambassador at Madrid that the Spanish Government have invited tenders for the construction and working of a telephone system in Mayagüez in Porto Rico. October 8th is the date fixed for the consideration of tenders, and such particulars as her Majesty's Government have received may be inspected at the Commercial Department of the Foreign Office between the hours of 11 and 6 daily.

**Mexico.**—August 31st. Sealed tenders will be received by the secretary of the City Council of the City of Mexico, for the lighting of the city by electricity. All information and conditions of tender, plan of the city of Mexico, &c., can be obtained on application at the Mexican Consulate, Broad Street House, New Broad Street, London.

**Newport (Mon.).**—*Daily Contracts* says that tenders are to be invited by the Harbour Commissioners for lighting the new landing stage, which is now nearly complete, by incandescent electric light.

**Roumania.**—September 4th. The Municipal Authorities of Jassy, Roumania, are inviting tenders for the electric lighting of the new abattoirs.

**Southampton.**—The time for sending in tenders for the electric cranes has been extended to August 31st, 1896.

**South Africa.**—October 1st. The Municipal Authorities of Bloemfontein are inviting tenders for supplying and laying down a complete electric lighting installation for the town. Tenderers are to submit a complete description, with plans and specifications, of their proposed scheme to W. A. Koller, Town Clerk, Bloemfontein, Orange Free State.

**Spain.**—August 29th. The Municipal Authorities of Nava del Rey are inviting tenders for the concession for the electric lighting of the town during a period of 20 years. Tenders to be sent to El Secretario del Ayuntamiento de Nava del Rey.

### CLOSED.

**Hapton (Padiham, Lancs.).**—The following tenders were sent in for lighting Hapton township with electricity from September 1st, 1896, to April 30th, 1897, for the Parish Council:—

| | |
|---|---|
| Simpson Bros., Hapton, near Burnley (accepted) .. .. | £124 |
| Sharp and Kent, Connaught Mansions, 34, Victoria Street, Westminster .. .. .. .. .. .. .. .. | 275 |

**Wakefield.**—The tender of Messrs. A. Broxup & Son (£2,743), for the construction of foundations and the erection of a chimney shaft at Calder Vale, for the electric lighting and sewage works of the Wakefield City Council has been accepted.

## NOTES.

**Li Chung Tang and Lord Kelvin.**—Lord Kelvin was introduced to Li Chung Tang on Tuesday last on board the *Marchioness of Lorne*, and the following is part of the conversation that took place:—

Li Chung Tang commenced by observing: I believe you are the first scientific man in the world; and then he asked how many students in a year passed through his hands.

Lord Kelvin replied that the number was about 200.

Li: How long have you been a Professor of Electricity and Natural Philosophy in the University of Glasgow?

Lord Kelvin: 50 years.

Li: Among this great number of students, does any of them ever become so great a scientific man as you are?

Lord Kelvin: I think that is for other people to judge, your Excellency. All my students, after leaving college, have become practical men, and they render good service to the people in that way. They do not necessarily devote their attention to the study of science as I do.

Li: Who succeeded you as President of the Royal Society in London?

Lord Kelvin: Sir John Lister, the first surgeon in London.

**An Apparatus for Showing Experiments with Ozone.**—The special feature of this apparatus, which has been devised by G. S. Newth, consists in a device for introducing reagents into the ozonised oxygen, without disturbing the volume of the gas. The reagent is contained in a sealed capillary tube, which is retained in position by means of four small raised points of glass upon the walls of the inner and outer tubes of the ozone apparatus. The inner tube is ground to fit the outer one, and by a slight turn of the former, the tube containing the reagent can be broken. In this way it is possible to show that the contraction in volume, due to the absorption of ozone by turpentine, is exactly twice as great as that which is produced by ozonising the oxygen, and also that when ozone is acted upon by potassium iodide, a volume of oxygen equal to that of the ozone is liberated. A full description of this apparatus was given at a recent meeting of the Chemical Society.

**Thermo-Piles.**—With reference to the article which appears on page 240 of our present issue, we may mention that a Clamond thermo-pile was in use for many years for working the local instruments in the late Submarine Telegraph Company's offices in London Wall. The continued and successful working of this pile was entirely due to the fact that the gas flames used for heating it were kept continuously alight. There is nothing, we believe, so destructive to a thermo-pile as continued alternations of heat and cold.

**Motor-Car Fatality.**—We hear that a dreadful occurrence attended the exhibition run of a motor-car at the Crystal Palace on Monday evening. A Mrs. Driscoll was knocked down by one of these carriages, and so seriously injured that death quickly ensued.

**A Plain Statement About Blackpool.**—Mr. Robert C. Quin, the recently-appointed engineer to the Blackpool Corporation, has, in a report presented to the Lighting Committee, spoken pretty plainly concerning the municipal system. He considers that the committee were well advised in adopting the high pressure alternating system, but he is not satisfied that the plant and machinery were the best that could have been used, nor that the class of mains, and their method of laying, were best calculated to give a reliable and economical supply. . . . . He states that none of the engines and dynamos can be termed highly efficient, and that the committee cannot but regret their choice when the large area required, and the large outlay needed for buildings to accommodate that particular type are taken into consideration. At the same time he does not recommend their replacement, seeing the very large amount of capital such a course would entail. In regard to the mains, he says cables have been rammed and jambed into the pipes until there is an average of six cables per pipe, and if one breaks down the whole lot will follow suit. The high tension rubber cables have perished on all sides, and must be replaced by more lasting ones, and different methods adopted in laying them. The arc-lighting cables are similarly situated; in fact, he does not think there are 100 yards out of the 11¼ miles laid which is worth more than its price as scrap copper. The repeated street-lighting failures are evidence of this deterioration; and the breakdown of one cable, in nine cases out of ten, means the burning asunder of the other cables in the same pipe. He attributes these failures to the action of the salt water, and he recommends the entire replacement of the cables by lead-covered ones laid in asphalte a foot beneath the surface of the pavement. The defects of the street boxes are noted, and the sheer luck which has alone prevented accidents similar to those at London and Bournemouth. He estimates the additional cost of modifying the high tension mains to be £1,200, those of the low tension £3,000, and of the transformer chambers £1,300, or a total of £5,500. While there was every probability that under ordinary circumstances the deficit of £716 on the year's working would have been wiped off, he is afraid that the special and exceptional conditions now prevailing at the works will not admit of this, and if they pull through the year with any profit at all it will be very encouraging. Mr. Quin proposes a new scale of charges to come into operation next year on the Brighton system. The cost necessary to carry out this reform is £700, or 1·5 per cent. on the capital at present invested, while the work of raising the pressure of supply from 100 to 200 volts and distributing it on the two-wire system, which he also recommends, will absorb an additional £650. He recommends that the tramways shall receive their current from the electrical works instead of generating their own, thus profitably utilising the plant at a time when it is generally lying idle. Mr. Quin strongly impressed upon the committee his sense of the hopelessness of the future prosperity of the works unless some immediate steps are taken to remedy the defects he has indicated. In an appendix is set forth the relative statements of how it has been proposed to employ the sum of £11,689 which yet remains of the borrowing powers, and how he proposes to utilise it under prevailing conditions.

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**It Depends.**—"That man wouldn't take a thousand dollars for those scars," remarked the president of a street railway company, pointing to a man whose face looked as if some one had been drawing a map of Europe on it with a razor. "He got them fighting duels at Heidelberg University, and he's prouder of them than of anything he owns; and yet if he got scarred up half as badly in an accident on our road he would think $25,000 was small pay for them."—*Street Railway Review.*

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**Appointment Vacant.**—The Hammersmith Vestry want a resident electrical engineer at a salary of £200 per annum, to supervise, under the consulting engineer, the erection of the electric lighting plant and other works in connection therewith. When the work is completed he will be required to undertake the management and control of the electric light department at £250 per annum. For further details, see our "Official Notices."

**Dynamo for Röntgen Ray Apparatus.**—In order to supply the demand for small alternating current dynamos for the operation of induction coils, the Kent Electric Manufacturing Company, of Worcester, Mass., has remodelled its standard direct-current dynamo for the purpose, and states that the remodelled machine gives successful results. Our illustration of the dynamo is taken from the N.Y. *Electrical World.* The company makes a water motor, which is capable

of running the alternating-current machine, the combination of the two making a very compact and convenient outfit. The dynamo, however, may be operated by any other power. This apparatus, the company claims, will give a suitable current for Röntgen ray experiments, and will be found very useful and convenient by experimenters who have not the use of regular alternating currents.

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**Technical Education.**—The opportunity for securing a thorough technical education by attending evening classes is a boon which, very naturally, is taken advantage of by certain sections of the British public, but the movement is not patronised to such an extent as one would anticipate when the circumstances are taken into account. In these welcome days of shorter hours of labour one would expect that a good proportion of the young and rising generation, with a burning ambition to succeed, would embrace more readily the facilities of this kind which are scattered broadcast, and thus lay a good foundation upon which to build a successful future. The plodding young man hears a good deal of sacrificing the health of the body to the training of the mind, and, of course, this, as everything else, can be carried to the extreme, but we venture to believe that there is a danger of the tide turning in the opposite direction; this is apparent from the apathy with which many lads and youths view the matter in these days, comforting themselves with the thought that sufficient unto the day is the knowledge thereof, instead of ever seeking to know something new. Now, at the People's Palace (East London Technical College) the programme of whose 1896-7 Session is before us, there is a very complete set of classes arranged where one can learn almost anything and everything, from simple addition and letter writing to electrical and mechanical engineering, chemistry, physics, and such like sciences. From this programme an excellent and varied course of classes might be chosen at very moderate fees, including manual training, gymnastic exercises, music, singing, &c. So we would recommend those for whom the classes are intended to obtain a copy of the programme which has just been issued. We understand that considerable developments have been made for this session, more especially in extending and systematising the instruction in the day classes.

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**Personal.**—We exceedingly regret to hear that Sir David Salomons, in his enthusiasm over the horseless carriage movement, has overtaxed his strength, and is so seriously indisposed that his doctor has forbidden him to take any active part in work for some time. It must be a source of considerable satisfaction to Sir David to know that the Bill for which he has been labouring so earnestly is now an Act.

**Superheating Steam.**—Commenting on superheating, the *Electrical World* says that the expansion may be carried throughout the entire cycle (Carnot) without condensation, the weight of steam for a given amount of work becomes less, and the whole condensing system may be reduced. Just what is meant by the expansion being carried through the entire cycle is not clear. Possibly greater expansion is meant, but it is not likely that there is no cylinder condensation with the amounts of superheat yet attempted. The actual additional heat is very small, and Prof. Thurston disclaims any thermo-dynamic value in superheated steam. He is right; there is next to none, simply because the extra heat is so little. Nevertheless, he admits the practical value of superheating as a means of counteracting the undesirable effects of the cylinder metal, and this is what we have long insisted upon as the root of the economy. Prof. Schroeter found a reduction from 13·4 lbs. of steam per I.H.P. with jacketed cylinders to 12·1 lbs. with superheat. Tests of the Schmidt system with steam at 675° F. showed only 10·2 lbs. of steam per I.H.P., and a coal consumption of only 1·28 lbs. With steam there are now only two lines along which economy seems possible, namely, superheat and pressure. Extra pressure gives but little further economy, owing to the complications in using it. Superheat can hardly be used to advantage—being so small a thermo-dynamic gain beyond the point when it enables a dry exhaust to be produced. We are, in fact, in sight of the final limit with existing practical possibilities.

**Electrolytic Magnesium and Antimony.**—In the electrolytic preparation of magnesium the difficulty hitherto has been due to the fact that the metal is not obtained in compact masses, but in small spheres which cannot readily be made to unite. This is no doubt due to a thin coat of magnesia on the surface of the metal, which is attributed partly to an impurity of magnesium sulphate in the carnallite used as raw material, and partly to the presence of aqueous vapour. It is therefore necessary to remove the impurities and to protect the melt from contact with aqueous vapour. A trace of magnesia still present, after purification, can be rendered harmless by the addition of fluorspar. F. Oettel describes an apparatus for the preparation of magnesium on a small scale in the laboratory, *vide Zeitschrift für Elektrotech* 2, p. 394. Electro-deposited antimony is now beginning to appear in the market in very brittle grey plates, 2 mm. in thickness, with the striated or modular surface at the back, which is characteristic of metals so obtained, but on the other side it is smooth, lustrous, and, in places, silver white. The fracture is white and crystalline, and the depositing bath is a solution of a sulphantimonite. Analyses of the deposit before and after fusion are as follows:—

| | Unfused. Per cent. | Fused to Regulus. Per cent. |
|---|---|---|
| Iron ... ... ... ... | 0·008 | 0·0046 |
| Lead and copper ... ... | Trace | 0·0084 |
| Sodium ... ... ... ... | 0·014 | ... |
| Arsenic ... ... ... ... | ... | ... |
| Sulphur ... ... ... ... | 0·288 | 0·0001 |
| Antimony ... ... ... | 99·690 | 99·9869 |

This new commercial product is fully described in the *Zeitschrift für Elektrochemie*, 1896; 2, p. 524, p. 525.

**Bankruptcy Proceedings.**—A receiving order was made yesterday at the London Bankruptcy Court against Messrs. Paterson & Cooper, electrical engineers, of Princes Mansions, Victoria Street, Westminster, the European Works, Dalston, and at Glasgow. The liabilities are roughly estimated at £21,000, and the assets at £16,000, consisting of stock, £10,000; plant and machinery, £5,000; and book debts, £1,000. Messrs. Routh, Stacey and Company presented the petition on behalf of the debtors, who have several contracts now on hand, and pay out £200 weekly for wages.

**Telegraph Tariff between Europe and China.**—It may be interesting to some of our readers to know that one of the principal features of the working agreement recently come to between the Eastern Extension and Great Northern Telegraph Companies and the Chinese Telegraph Administration is, that the tariff between Europe and China is to be reduced next year from 8.50 francs to 7.00 francs per word.

**Disturbance of Telegraph and Telephone Circuits by Light and Power Current.**—Some interesting statistics with regard to disturbances of telegraph and telephone circuits by lighting and power currents have been compiled by the German Imperial Post Office, and were communicated to the *Elektrotechnischer Verein*, of Berlin, by Dr. Strecker, a little time ago. The statistics cover the period 1891—96, and give 76 cases of damage to circuits and apparatus. In 1891 there were five cases, in 1892 four cases, in 1893 two cases, in 1894 15 cases, in 1895 31 cases, and in 1896, for the first four months, 19 cases. The increase in the number of disturbances is explained by the increase of electric tramways. In almost all cases it was telephone circuits that suffered, and only two cases of damage to telegraph lines are reported. In 61 cases electric railways caused the disturbance, and in 15 cases electric lighting plants. In 59 cases the safety devices, such as wooden strips, guard wires, &c., failed to act. In 40 of the 76 cases the telephone or telegraph wire broke, and had been in contact with the live circuit. Many disturbances were caused during the stringing of the telegraph or telephone wire, and also by broken guard wires themselves. The damage caused, however, was mostly small, on an average of about $3.50. There were, however, two fires in 1894 at Dortmund and Barmen, and the damage amounted to $1,350 and $7,750. To protect instruments from currents of two high pressure the German Post Office puts fuses into the circuits. These fuses consist of a wire 0·07 mm. in diameter, and made of a non-oxidisable alloy. They are enclosed in glass tubes 5 cm. to 6 cm. long, sealed up at both ends, and fitted with metal contact pieces. In this way the formation of an arc at 500 volts pressure is avoided. The fusing current of the wire is 0·8 ampere. The whole fuse is kept in position between contact springs, and is easily interchangeable. Another type of fuse used by the Imperial Post Office consists of a porcelain block, about 5 cm. high, the fuse wire running through a hole across the block. Both types, according to the New York *Electrical Engineer*, have given great satisfaction.

**Storage Batteries in America.**—According to an American exchange, the adoption of the storage battery in central station practice in America seems to be an assured fact. Within the past few weeks the Electric Storage Battery Company has contracted to instal batteries of chloride accumulators in the stations of the Boston Edison Company (their third plant), the New York Edison Company (their second plant), the Brooklyn Edison Company, the Easton, Pa., Edison Company, the Hartford Electric Light Company (said to be the largest battery in the world), the Claremont, N.H., Electric Light Company, the Woonsocket, R.I., Electric Machine and Power Company, &c. The company has also recently closed contracts with the Government for batteries for the New York Custom House, West Point Military Academy, Ford's Theatre, Washington, D.C., which is a Government building, and the Brooklyn Navy Yard.

**Combination of Lamp Manufacturers in America.**—The *Western Electrician* is responsible for the following:—"It is stated by many men in the business that the leading incandescent lamp manufacturers of the country, at the recent conference in New York, drew up an agreement to maintain a fixed schedule of prices. Exact details of the arrangement have not been made public, but it is asserted that several companies have signed the articles of agreement, and that others are expected to do so. The agreement is entered into for the purpose of restoring the 20-cent rate, and to prevent the disastrous rate-cutting that has prevailed in the lamp business for a year or so past. For this purpose, it is said, each company puts up a forfeit of $5,000 to guarantee good faith, and it is understood that the fine for selling below the fixed rate is to be 10 cents per lamp."

**Progress.**—The Portsmouth Council has adopted an important recommendation of the Electric Light Committee, which should make electric heating and cooking very popular in the neighbourhood. They will in future let out on hire electric motors and electric ovens to consumers, at 15 per cent. on the cost price.

**Gas Accident.**—At some drug stores at Crewe a leakage of gas caused a serious explosion the other day.

## NEW COMPANY REGISTERED.

**Central London Omnibus Company, Limited** (49,122).—Registered August 13th, capital £1,000 in £1 shares, to carry on in the United Kingdom and elsewhere the business of electricians, electrical and mechanical engineers, manufacturers and owners of electric vehicles, carriages, workers and dealers in electricity, electric machines, appliances, apparatus, motive power, traction, heat, and light. The subscribers (with one share each) are:—G. Cox, 3, Salter's Hall Court, E.C., solicitor; J. Lafone, 3, Salter's Hall Court, E.C., solicitor; P. H. Senior, 42, Laithwood Road, Balham, S.W.; H. A. Moore, 3, Salter's Hall Court, clerk; A. J. McMillar, 3, Salter's Hall Court, secretary; B. Jackson, 28, Fenchurch Street, E.C., C. A.; W. B. Parsons, 3, Salter's Hall Court, clerk. Registered without articles of association. Registered office, 3, Salter's Hall Court, Cannon Street, E.C.

## OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

**Gorseinon Electric Light Company, Limited** (39,944).—This company's annual return has just been filed. The capital is £1,000 in £1 shares, and all have been taken up; 16s. per share has been called, and £784 18s. has been paid, and £15 2s. remains unpaid.

**Hooper's Telegraph and India-Rubber Works, Limited** (40,947).—This company's annual return was filed on June 8th. The capital is £50,000 in £10 shares (of which 1,000 are preference); 1,000 preference and 1,050 ordinary have been taken up, and the preference are considered as paid. £10 per share has been called on 550 ordinary, and £2 per share on the rest, and £6,500 has been paid in consequence.

**Hargreaves & Shaw, Limited** (43,142) (electrical engineers and electricians, of Ashton-under-Lyne).—The final meeting in connection with the winding up of this concern was held at 10, Norfolk Street, Manchester, on June 23rd, when the accounts were presented and adopted.

## CITY NOTES.

### New Zealand Electrical Syndicate, Limited.

An adjourned ordinary general meeting of the New Zealand Electrical Syndicate, Limited, was held on Monday at Cannon Street Hotel, E.C, Mr. de Castro presiding.

Before the proceedings commenced, Mr. Huxtable, on behalf of certain persons, entered a protest against the legality of the meeting, which he said had not been properly adjourned. He asserted that Messrs. Boustead and Savory had been elected directors in place of Messrs. de Castro and Grewing, who, however, retained office. The meeting was adjourned by a tacit resolution of the shareholders, although Mr. Lewis and himself protested.

The Chairman: Then you have your remedy.

The Secretary read the minutes of the original meeting, stating that it was adjourned in consequence of there not being a quorum present, and the chairman proceeded to sign them, in spite of a protest from Mr. Huxtable, who said he had the opinion of Mr. Cozens-Hardy, Q.C., to the effect that the election of Messrs. Boustead and Savory to the board was in order.

The Chairman went on to say that the directors had been unable to obtain any information from the receiver and manager of the company, who was in possession of all the company's property and books of account, as to the position of the company. They were, therefore, unable to present any accounts or any balance-sheet to the shareholders. Under these circumstances, both the directors were anxious to retire from the board, and tendered their resignations to the shareholders; but, as the company might be placed in a very difficult position if they vacated their seats without providing for the election of their successors, they were willing to remain in office until new directors had been elected by some properly-constituted meeting of the shareholders. The chairman then declared the meeting closed.

### A New Insurance Office.

A prospectus was issued a few days ago by the Merchants' Fire Office, Limited, which has a nominal capital of £1,000,000, divided into £5 shares, offering for subscription a first issue of 100,000 shares at par. One of the most important objects of the company is to charge fair premiums, rating all risks on their merits. There are several trades which are charged exorbitant and almost prohibitive rates, and recent heavy increases have created widespread dissatisfaction. It is therefore with the laudable desire to offer equitable premiums that the Merchants' Fire Office is being launched. The prospectus before us cites a number of trades which are handicapped, including printing establishments, but we venture to believe that the electrical factories and central lighting stations are mulcted in heavy premiums with quite as much, if not more, inconsistency than are some of the other branches of industry referred to. The directors would have done well to include this class of insurance in their list, for in view of the increases recently made by various offices trebling the premiums, there is room for an office which will charge a fair rate, and we would recommend the company to pay special attention to this branch of insurance business. The directors state that they are prepared to give special encouragement, in the form of reduced rates and liberal discounts, to the owners and occupiers of property who introduce the electric light, which, "when installed upon safe scientific principles, is known to be less hazardous than any other illuminating medium." This is a good feature.

### Cuba Submarine Telegraph Company, Limited.

The ordinary general meeting of this company was held on Wednesday at the offices, 58, Old Broad Street, Mr. E. W. Parrish presiding.

The Chairman, in moving the adoption of the report, remarked that during the past six months the cables had worked well, and the company had earned a larger sum of money than in any previous half-year of its existence. The gross receipts amounted to £36,186, and the gross expenditure to £9,425, leaving a sum of £26,761, which, added to the balance of £3,719 brought forward from the last account, left £30,481 to the credit of revenue account. The increased traffic and the cost of working the five new stations of the Cienfuegos-Manzanillo cables, which were opened at the commencement of the year, accounted for the increase in the station expenses. The sum of £17,910 had been added to the reserve fund, which now stood at £98,000 after deducting the cost of the cables between Cienfuegos and Manzanillo. Satisfactory as the results of the half-year's working were, the six months had been a period of anxiety to the directors, not only on account of the disturbed political state of the island of Cuba, but also by reason of the great agitation which was going on amongst the promoters of fresh cables and fresh cable schemes and new companies all over the world. Interested parties were pressing numerous suggestions upon some of the European Governments to connect their colonies together by the particular cables belonging to these parties, and the French Government had been particularly active in this respect. How far these proposals were practical, or how far they were needed remained to be seen. He thought the necessities and advantages of the proposed cables were somewhat exaggerated, but the company must nevertheless be ready to face any new situations which might arise. The British Government were considering the necessity of a cable from Jamaica to Bermuda, and had been in negotiation with the allies of that company and the company itself on the matter. The scheme was not a new one, and was really part of the original plan to have a cable from Halifax to Bermuda, and then from Bermuda down to Jamaica, but at present the cable only existed from Halifax to Bermuda. To continue it from the latter place to Jamaica would be somewhat difficult, and the matter was still under consideration.

Mr. G. Keith seconded the motion, which was agreed to.

A dividend at the rate of 8 per cent. per annum on the ordinary shares was declared.

**The City of London Electric Lighting Company, Limited.**—Mr. J. Cecil Bull (manager and secretary) furnishes the following returns relating to this company:—Revenue return, quarter ended June, 1896:—Gross revenue from sale of current for public lighting, quarter ended June 30th, 1896, £3,189; corresponding quarter last year, £3,202; gross revenue from sale of current for private lighting, &c., quarter ended June 30th, 1896, £16,564; corresponding quarter last year, £12,283; gross revenue from other sources (estimated), quarter ended June 30th, 1896, £650; corresponding quarter last year, £200; total, quarter ended June 30th, 1896, £20,403; corresponding quarter last year, £15,685; increase, £4,718; equivalent of 8 C.P. lamps connected on June 24th, 1896, 215,559; increase during quarter, 8,291; equivalent of 8 C.P. lamps connected on June 26th, 1895, 159,250; increase during corresponding quarter last year, 10,656.

**River Plate Electric Light and Traction Company, Limited.**—The River Plate Trust, Loan, and Agency Company announce that the scrip of the issue of £125,000 5 per cent. first debenture stock is now ready, and can be had at their offices, 52, Moorgate Street, E.C., in exchange for the allotment letters duly endorsed.

**The Brush Electrical Engineering Company, Limited.**—The transfer books of the first debenture stock of the Brush Electrical Engineering Company, Limited, will, in view of interest payable on September 1st, 1896, be closed from August 19th, 1896, to September 1st, 1896, both inclusive.

**Stock Exchange Notices.**—Application has been made to the Committee to appoint a special settling day in British Aluminium Company, Limited, 8,697 preference shares of £10 each, and to allow 12,500 ordinary shares of the Metropolitan Electric Supply Company to be quoted in the Official List.

## TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending August 16th, 1896, were £1,110; week ending August 18th, 1895, £924; increase, £186; total receipts for half-year, 1896, £6,529; corresponding period, 1895, £6,008; increase, £521.

The Liverpool Overhead Railway Company. The receipts for the week ending August 16th, 1896, amounted to £1,875; corresponding week last year, £1,374; increase, £1.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending August 14th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company Limited, were £2,744.

# SHARE LIST OF ELECTRICAL COMPANIES.

## TELEGRAPH AND TELEPHONE COMPANIES.

| Present issue. | NAME. | Stock or Share. ‡ | Dividends for the last three years. 1893. | 1894. | 1895. | Closing Quotation, Aug. 12th. | Closing Quotation, Aug. 19th. | Business done during week ended Aug. 19th, 1896. Highest. | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| 173,400£ | African Direct Teleg., Ltd., 4 % Deb. ... ... ... | 100 | 4 % | 4 % | 4 % | 100 —104 | 100 —104 | ... | ... |
| 25,000 | Amazon Telegraph, Limited, shares... ... ... ... | 10 | ... | ... | ... | 8½— 9½ | 8½— 9½ | 8½ | ... |
| 1,012,880£ | Anglo-American Teleg., Ltd. ... ... ... ... ... | Stock | £2 11s. | £2 2s. | £2 9s. | 52 — 54 | 52 — 54 | ... | ... |
| 2,993,560£ | Do. do. 6 % Pref. ... ... ... ... ... | Stock | £5 2s. | £4 4s. | £4 18s. | 97½— 98½ | 97½— 98½ | 98½ | 97½ |
| 2,993,560£ | Do. do. Defd. ... ... ... ... ... ... | Stock | ... | ... | ... | 9 — 9½ | 9 — 9½ | ... | ... |
| 130,000 | Brasilian Submarine Teleg., Ltd. ... ... ... ... | 10 | 6½% § | 7 % | ... | 15¼ — 15⅝ | 15¼ — 15⅝ | 15⅝ | 15⅜ |
| 75,000£ | Do. do. 5 %, Debs., 2nd series, 1906 ... ... | 100 | 5 % | 5 % | 5 % | 112 —116 | 112 —116 | ... | ... |
| 44,000 | Chili Telep., Ltd., Nos. 1 to 44,000 ... ... ... | 5 | ... § | 2½% | 4 % | 3½— 4 | 3½— 4 xd | ... | ... |
| 10,000,000$ | Commercial Cable Co. ... ... ... ... ... | $100 | 7 % | 7 % | 7 % | 160 —170 | 160 —170 | ... | ... |
| 224,850 | Consolidated Telep. Const. and Main., Ltd. ... ... | 10/- | 2 % § | 1½% | 1½% | 1/16— 3/16 | 1/16— 3/16 | ... | ... |
| 16,000 | Cuba Teleg., Ltd. ... ... ... ... ... ... | 10 | 8 % | 8 % | 8 % | 12½— 13½ | 12½— 13½ | ... | ... |
| 6,000 | Do. 10 % Pref. ... ... ... ... ... | 10 | 10 % | 10 % | 10 % | 20 — 21 | 20 — 21 | 20¾ | ... |
| 12,931 | Direct Spanish Teleg., Ltd. ... ... ... ... | 5 | 4 % | 4 % | 4 % | 3½— 4½ | 3½— 4½ | ... | ... |
| 6,000 | Do. do. 10 % Cum. Pref. ... ... ... | 5 | 10 % | 10 % | 10 % | 10 — 10½ | 10 — 10½ | ... | ... |
| 30,000£ | Do. do. 4½ % Debs. Nos. 1 to 6,000 ... | 50 | ... | 4½% | 4½% | 107 —110% | 107 —110 % | ... | ... |
| 60,710 | Direct United States Cable, Ltd. ... ... ... ... | 20 | 2⅝% § | 2 % | 2½% | 9¾— 10¼ | 9¾— 10¼ | 10⅛ | 9⅞ |
| 400,000 | Eastern Teleg., Ltd., Nos. 1 to 400,000 ... ... | 10 | 6½% § | 6½% | 6½% | 18 — 18½ | 18 — 18½ | 18⅜ | 18⅛ |
| 70,000 | Do. 6 % Cum. Pref. ... ... ... ... | 10 | 6 % § | 6 % | 6 | 18½— 19½ | 18½— 19½ | 19⅜ | 19¼ |
| 102,100£ | Do. 5 % Debs., repay. August, 1899 ... ... | 100 | 5 % | 5 % | 5 % | 104 —107 | 104 —107 | ... | ... |
| 1,297,837£ | Do. 4 % Mort. Deb. Stock Red. ... ... | Stock | 4 % | 4 % | 4 % | 131 —134 | 131 —134 | 133½ | 131¼ |
| 250,000 | Eastern Extension, Australasia and China Teleg., Ltd. ... | 10 | 7 % | 7 % | 7 % | 18 — 18½ | 18 — 18½ | 18⅜ | 18⅛ |
| 54,100£ | Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 | 100 | 5 % | 5 % | 5 % | 100 —104 | 100 —104 | ... | ... |
| 194,300£ | Do. do. Bearer, 1,050—3,975 and 4,327—6,400 | 100 | 5 % | 5 % | 5 % | 101 —104 | 101 —104 | ... | ... |
| 320,000£ | Do. 4 % Deb. Stock ... ... ... ... ... | Stock | 4 % | 4 % | 4 % | 130 —133 | 130 —133 | 133 | 131½ |
| 80,600£ | Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343 | 100 | 5 % | 5 % | 5 % | 100 —104 | 100 —104 | ... | ... |
| 107,600£ | Do. do. do. to bearer, 2,344 to 5,500 | 100 | 5 % | 5 % | 5 % | 101 —104 | 101 —104 | ... | ... |
| 300,000£ | Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909 | 100 | 4 % | 4 % | 4 % | 105 —108 | 106 —109 | ... | ... |
| 200,000£ | Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000 | 25 | 4 % | 4 % | 4 % | 111 —114 % | 111 —114 % | 112¼ | ... |
| 180,227 | Globe Telegraph and Trust, Ltd. ... ... ... ... | 10 | 4⅝% § | 4½% | 4½% | 11¼— 11⅜ | 11¼— 11⅜ | 11⅜ | 11½ |
| 180,042 | Do. do. 6 % Pref. ... ... ... | 10 | 6 % § | 6 % | 6 % | 18 — 18½ | 18 — 18½ | 18⅜ | 18 |
| 150,000 | Great Northern Teleg. Company of Copenhagen ... ... | 10 | 8⅜% | 8⅜% | 10 % | 23½— 24½ | 23½— 24½ | 24¼ | 24 |
| 180,000£ | Do. do. do. 5 % Debs. | 100 | 5 % | 5 % | 5 % | 105 —108 | 105 —108 | ... | ... |
| 17,000 | Indo-European Teleg., Ltd. ... ... ... ... ... | 25 | 10 % | 10 % | 10 % | 53 — 56 | 53 — 56 | ... | ... |
| 100,000£ | London Platino-Brasilian Teleg., Ltd. 6 % Debs. ... ... | 100 | 6 % | 6 % | 6 % | 111 —114 | 111 —114 | ... | ... |
| 28,000 | Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ... | 5 | 4 % | 4 % | ... | 2 — 2½ | 2 — 2½ | ... | ... |
| 484,597 | National Teleph., Ltd., 1 to 484,597 ... ... ... ... | 5 | 5 % § | 5 % | 5½% | 7⅞— 8 | 7⅞— 7⅞ xd | 7⅞ | 7 11/16 |
| 15,000 | Do. 6 % Cum. 1st Pref. ... ... ... | 10 | 6 % | 6 % | 6 % | 17 — 19 | 17 — 19 xd | ... | ... |
| 15,000 | Do. 6 % Cum. 2nd Pref. ... ... | 10 | 6 % | 6 % | 6 % | 17 — 18 | 17 — 18 xd | 17⅜ | ... |
| 119,234 | Do. 5 % Non-cum. 3rd Pref., 1 to 119,234 | 5 | 5 % | 5 % | 5 % | 6⅞— 7⅛ | 6¾— 7 xd | 6⅞ | 6 13/16 |
| 1,100,000£ | Do. 3½ % Deb. Stock Red. ... ... | Stock | 3½% | 3½% | 3½% | 107 —110 | 107 —110 | 108 | ... |
| 171,504 | Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid | 1 | ... | 4½% | 5 % | ¾— ⅞ | ¾— ⅞ | ... | ... |
| 100,000£ | Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000 | 100 | 4 % | 4 % | 4 % | 108 — 111 | 108 —111 | ... | ... |
| 11,839 | Reuter's Ltd. ... ... ... ... ... ... ... | 8 | 0 % | *nil* | 5 % | 7 — 8 | 7 — 8 | ... | ... |
| 3,361 | Submarine Cables Trust ... ... ... ... ... | Cert. | ... | ... | ... | 140 —145 | 140 —145 | 141 | ... |
| 58,000 | United River Plate Teleph., Ltd. ... ... ... ... | 5 | ... | 3 % | 4 % | 3¾— 4¼ | 3¾— 4¼ | ... | ... |
| 146,733£ | Do. do. 5 % Debs. ... ... ... | Stock | 5 % | 5 % | 5 % | 101 —106 | 101 —106 | ... | ... |
| 15,609 | West African Teleg., Ltd., 7,501 to 23,109 ... ... ... | 10 | *nil* | *nil* | 4 % | 5 — 6 | 5 — 6 | ... | ... |
| 238,300£ | Do. do. do. 5 % Debs. ... ... ... | 100 | 5 % | 5 % | 5 % | 104 —107 | 104 —107 | ... | ... |
| 30,000 | West Coast of America Teleg., Ltd. ... ... ... ... | 10 | *nil* | *nil* | *nil* | 1 — 2 | 1 — 2 | 1 | ... |
| 150,000£ | Do. do. do. 8 % Debs., repay. 1902 | 100 | 8 % | 8 % | 8 % | 99 —104 | 99 — 104 | ... | ... |
| 64,248 | Western and Brasilian Teleg., Ltd. ... ... ... ... | 15 | 2½% | 3 % | 3 % | 8¾— 9¼ | 8¾— 9¼ | 9¼ | ... |
| 33,129 | Do. do. do. 5 % Pref. Ord. ... | 7½ | 5 % | 5 % | 5 % | 7 — 7½ | 7 — 7½ | 7⅝ | ... |
| 33,129 | Do. do. do. Def. Ord. ... ... | 7½ | ... | 1 % | 1 % | 2¼— 2⅜ | 2¼— 2⅜ | ... | ... |
| 165,200£ | Do. do. do. 6 % Debs. "A," 1880 Red. | 100 | 6 % | 6 % | 6 % | 103 —107 | 103 —107 | ... | ... |
| 206,400£ | Do. do. do. do "B," do. | 100 | 6 % | 6 % | 6 % | 103 —107 | 103 —107 | ... | ... |
| 88,321 | West India and Panama Teleg., Ltd. ... ... ... | 10 | ⅞% | 1⅛% | ⅞% | 1⅛— 1⅜ | 1⅛— 1⅜ | 1¼ | ... |
| 34,563 | Do. do. do. 6 % Cum. 1st Pref. | 10 | 6 % | 6 % | 6 % | 11½— 12 | 11½— 12 | 11⅝ | 11 11/16 |
| 4,669 | Do. do. do. 6 % Cum. 2nd Pref. | 10 | 6 % | 6 % | 6 % | 9½— 10½ | 9½— 10½ | ... | ... |
| 80,000£ | Do. do. 5 % Debs. No. 1 to 1,800 ... | 100 | 5 % | 5 % | 5 % | 108 —111 | 108 —111 | 111 | ... |
| 1,777,000$ | Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ... | $1000 | 7 % | 7 % | 7 % | 110 —115 | 110 —115 | 110 | ... |
| 164,300£ | Do. do. 6 % Ster. Bonds. ... ... | 100 | 6 % | 6 % | 6 % | 104 —107 | 104 —107 | ... | ... |

## ELECTRICITY SUPPLY COMPANIES.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 30,000 | Charing Cross and Strand Electy. Supply ... ... ... | 5 | 4½% | 4½% | 5 % | 8⅝— 9¼ | 8⅝— 9¼ | 9 3/16 | 9 |
| 10,277 | *Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ... | 5 | 5 % | 5 % | 5 % | 7⅞— 8½ | 7⅞— 8½ | 8⅛ | 8 |
| 60,000 | Do. do. do. 4½ % Deb. Stock Red. ... | Stock | ... | ... | 4½% | 114 —116 | 114 —116 | ... | ... |
| 40,000 | City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000 | 10 | ... | 5 % | 5 % | 15½— 16½ | 16 — 17 | 16⅝ | 16 |
| 40,000 | Do. do. 6 % Cum. Pref., 1 to 40,000 | 10 | 6 % | 6 % | 6 % | 17 — 18 | 17½— 18½ | 18 | 17½ |
| 300,000 | Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid | ... | 5 % | 5 % | 5 % | 133 —137 | 133 —137 | ... | ... |
| 22,475 | County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475 | 10 | ... | ... | *nil* | 8 — 9 | 8 — 9 | ... | ... |
| 20,000 | Do. do. do. 6% Pref., 40,001—50,000 ... | 10 | ... | ... | 6 % | 13½— 14 | 13½— 14 | 14⅛ | 13 15/16 |
| 10,000 | Do. do. do. iss. at 2 pm., £1 paid ... ... | 10 | ... | ... | ... | 3½— 4½ | 3½— 4½ | 3 13/16 | ... |
| 49,900 | *Metropolitan Electric Supply, Ltd., 101 to 50,000 ... | 10 | 2½% | 3 % | 4 % | 13½— 13⅝ | 13½— 13⅝ | 13⅝ | 13⅜ |
| 100,000£ | Do. 4½% first mortgage debenture stock ... ... | ... | 4½% | 4½% | 4½% | 119 —123 | 120 —123 | 121½ | 121 |
| 6,452 | Notting Hill Electric Lightg. Co., Ltd. ... ... ... | 10 | ... | 1 % | 2 % | 11 — 12 | 11 — 12 | 12 | ... |
| 19,980 | *St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080 | 5 | 4½% | 6½% | 7½% | 12½— 13½ | 12½— 13½ | 13¼ | 13 |
| 20,000 | Do. do. 7 % Pref., 20,081 to 40,080 | 5 | 7 % | 7 % | 7 % | 10 — 11 | 10 — 11 | ... | ... |
| 50,000 | Do. do. 4 % Deb. stock Red. ... | Stock | ... | ... | ... | 104 —107 | 105 —108 | 107 | ... |
| 67,900 | *Westminster Electric Supply Corp., Ord., 101 to 60,000 | 5 | 4 % | 5 % | 7 % | 11 — 12 xd | 11 — 12 xd | 11⅜ | 11⅜ |

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

§ Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

## SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

### ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

| Present Issue. | NAME. | Stock or Share. ‡ | Dividends for the last three years. 1893. | 1894. | 1895. | Closing Quotation, Aug. 12th. | Closing Quotation Aug. 19th. | Business done during week ended Aug. 19th, 1896. Highest. | Lowest |
|---|---|---|---|---|---|---|---|---|---|
| 90,000 | Brush Elecl. Enging. Co., Ord., 1 to 90,000 ... ... ... | 3 | 5 % | 2½% | ... | 1 — 1¼ | 1 — 1¼ | ... | ... |
| 90,000 | Do. do. Non-cum. 6 % Pref., 1 to 90,000 | 2 | 6 % | 3 % | ... | 1⅛— 1⅛ | 1⅛— 1⅛ | ... | ... |
| 125,000 | Do. do. 4½ % Perp. Deb. Stock. ... ... | Stock | 4½% | 4½% | ... | 112 —115 | 112 —115 | ... | ... |
| 76,770 | Do. do. 4½% 2nd Deb. Stock Red. ... | Stock | ... | ... | ... | 98 — 102 | 98 —102 | ... | ... |
| 9,104 | Central London Railway, Ord. Shares ... ... ... | 10 | ... | ... | ... | 10½— 11 | 10½—11 | ... | ... |
| 207,649 | Do. do. do. £2 paid ... ... | 10 | ... | ... | ... | 2¼— 2½ | 2¼— 2½ | 2 7/16 | ... |
| 630,000 | City and South London Railway ... ... ... ... | Stock | 1 1/16% | 1⅛% | 1 3/16% | 46 — 48 | 47 — 49 | ... | ... |
| 28,180 | Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180 | 5 | 3 % § | *nil* | *nil* | 2 — 2½ | 2 — 2½ | ... | ... |
| 89,261 | Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261 | 5 | 7 % | 5 % | 5 % | 1¾— 2¼ | 1¾— 2¼xd | 2 3/16 | ... |
| 17,139 | Do. do. do. "A" Shares 01—017,139 | 5 | 7 % | 5 % | 5 % | 3 — 4 | 3 — 4 | ... | ... |
| 100,000 | Do. do. do. 4½% Deb. Stock Red. ... | Stock | ... | 4½% | 4½% | 103 —106 | 103 —106 | ... | ... |
| 110,000 | Electric Construction, Ltd., 1 to 110,000 ... ... ... | 2 | *nil* | *nil* | 5 % | 1⅝— 1⅞ | 1¾— 1⅞ | 1 13/16 | 1⅝ |
| 12,845 | Do. do. 7 % Cum. Pref., 1 to 12,845 ... | 2 | 7 % | 7 % | 7 % | 2⅜ — 3¼ | 2⅜— 3¼ | ... | ... |
| 91,195 | Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000 ... ... | 2 | *nil* | *nil* | ... | 9/16— 7/8 | 9/16— 1 | 9/16 | ... |
| 69,385 | Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ... | 2 | *nil* | *nil* | ... | 5/8— 5/8 | 5/8— 5/8 | ... | ... |
| 9,600 | Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ... | 10 | *nil* | *nil* | 10½% | 10½— 11½ | 10½— 11½ | ... | ... |
| 10,000 | Henley's (W. T.) Telegraph Works, Ltd., Ord. ... ... | 10 | 5 % | 6 % | 8 % | 17½— 18½ | 18 — 19 | 18⅝ | 17⅝ |
| 3,000 | Do. do. do. 7% Pref. ... ... | 10 | 7 % | 7 % | 7 % | 18 — 19 | 18½ — 19½ | ... | ... |
| 50,000 | Do. do. do. 4½ Mort. Deb. Stock | Stock | ... | ... | 4½% | 109 —114 | 112 —117 | 115 | ... |
| 50,000 | India-Rubber, Gutta Percha and Teleg. Works, Ltd. ... | 10 | 12½% | 10 % | 10 % | 22 — 23 | 22 — 23 | 22⅝ | 22 1/16 |
| 300,000 | Do. do. do. 4 % 1st Mort. Debs. | 100 | ... | ... | ... | 106 —109 | 107 —110 | ... | ... |
| 37,500 | †Liverpool Overhead Railway, Ord. ... ... ... ... | 10 | 1 % | 1½% | 2⅞% | 13⅜ — 13⅞ | 13½— 13⅝xd | ... | ... |
| 10,000 | † Do. do. Pref., £10 paid ... ... | 10 | 5 % | 5 % | 5 % | 17⅛— 17⅜ | 16⅞— 17⅜xd | ... | ... |
| 37,350 | Telegraph Constn. and Maintce., Ltd. ... ... ... | 12 | 20 % | 20 % | 15 % | 39 — 42 | 39 — 42 | 41¼ | 40 |
| 150,000 | Do. do. do. 5 % Bonds, red. 1899 | 100 | 5 % | 5 % | 5 % | 102 —105 | 102 —105 | ... | ... |
| 54,000 | Waterloo and City Railway, Nos. 1 to 54,000, £6 paid ... | 10 | ... | ... | ... | 8 — 8½ | 8 — 8½ | ... | ... |

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
Crompton & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%

### LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.
Electric Construction Corporation, 6 % Debentures, 104—107.
House-to-House Company (£5 paid), 4—4½.
Do. do. 7 % Preference, of £5, 8½—9.
Do. do. 4½% Debentures of £100, 109—111.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 9½—10xd; 1st Preference Cumulative 6 %, £5 (fully paid), 7⅜—8¼.
London Electric Supply Corporation, £5 Ordinary, 1—1¼.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 7½—7¾.

Bank rate of discount 2 per cent. (February 22nd, 1894).

## A CRITICISM OF THE SCIENCE AND ART EXAMINATION.

By W. PERREN MAYCOCK, M.I.E.E.

The examination referred to is that on *Magnetism and Electricity*, including "Group B" of the paper on *Alternative Elementary Physics*. The first thing one notices is that the cart is still put before the horse in the title of the subject—at any rate "Electricity and Magnetism" seems more in order than "Magnetism and Electricity," for generally speaking, it may be said that magnetism is an effect of electricity.

Those venerable and meaningless sub-divisions, "frictional electricity" and "voltaic electricity" are still adhered to, and it would be extremely interesting to know how the examiners define the difference between the two "kinds." What is the "negative electricity" referred to in Question 25, and how does it differ in its properties from the "positive electricity" mentioned in Question 48? Also, how can *more* "negative electricity" be put on to a conductor that is already negatively electrified (Question 25)? In Question 11 the proper term "electrification" is used, but here the student is required to say "*which names are the better—vitreous and resinous, or positive and negative—to distinguish between the different kinds of electrification? and why?*"!! Surely any reference to the former antiquated terms is quite unnecessary in a paper (Alternative Elementary Physics) in which only three questions are set on "frictional" electricity. In the second of these three questions the examinee is asked to state "*with what kind of electricity*" a proof plane will be electrified under given conditions: while in the third he is required to "*describe and explain the action of a simple frictional electrical machine.*" What an efficient apparatus for an 1896 student to trouble his head about, especially after all that Varley, Holtz, Tœpler, Kelvin, and Wimshurst have done!

What is the "insulating stool" mentioned in Questions 29 and 45? One certainly would not call the Ayrton and Perry insulating stand by such a name, and if the examiners mean a slab of wood with four plain glass or ebonite legs, even if they be varnished, the less said about the reliability of experiments performed therewith the better.

In Question 48 "an insulated ice-pail" is brought under notice. Now every student sitting for this examination had presumably heard of Faraday's ice-pail experiment; but was it not a bad plan to give him or her such an obvious clue to the answer; and besides, the logic of the question is faulty, for all ice-pails are not made of metal, as is obviously necessary for the proper working of the experiment. Indeed a wooden ice-pail would, under certain circumstances, be better than a metal one so far as its legitimate use was concerned.

In Question 30 it is required to show that the electrical conditions of the terminals of a battery differ from each other, "*and that the difference is of the same kind as that of the prime conductor and rubber of an electrical machine in action.*" This question is almost identical with two others set in the 1894 and 1887 papers respectively. Has electrical progress been so slow that it is necessary to dish up old examples, and such examples? What is a "prime conductor," and where are the prime conductor and rubber on a Wimshurst or any other modern type of electrical machine?

The time-honoured astatic and tangent galvanometers are of course mentioned (Questions 32 and 50), although questions relating to the former were set in 1892 and 1889, and others involving the principle of the latter appeared in the papers of 1892 and 1891, to go no further back. It is certainly time that attention was given to some other principles of galvanometer construction.

The following is Question 53 of the Advanced Stage paper: "*A wire is stretched from east to west (magnetic). How, without breaking it, can you test whether, and in what direction, an electric current is passing through it?*" In the 1893 and 1889 Elementary papers, questions were set in

which it was required to deduce the direction of deflection of a compass needle placed under a current-carrying wire running east and west, the direction of the current being given. These elementary questions of 1893 and 1889 are clearly kindred to the "advanced" question of 1896 above quoted. Here is retrogression with a vengeance!

If there is one subject more than another that the Science and Art student may be fairly certain that questions will be set upon, it is that of terrestrial magnetism. I have searched the papers as far back as 1885, and in every single year between and including that and the present year of grace are to be found examples thereon. In both the elementary and advanced papers, four questions are set each year in magnetism, and in not a few of the papers two and even three of the four were of the nature alluded to. No less than three of the elementary questions, and two of the advanced in this year's paper come more or less under the above category. The Science and Art idea of magnetism seems to centre chiefly in the magnetic meridian, dip and compass needles, and the components of the earth's magnetic force.

It is sad to reflect on the neglected opportunities of this examination, and to think of the useful problems that might have taken the place of those that present day electricians would take exception to. But we must be patient, for there are signs of improvement. Certain examples here and there bear the impress of modernity, and *mirabile dictu*, there is no reference this year to "galvanic" or "voltaic" batteries, Grove's cells, Volta's cell, torsion balances, and certain other terms and apparatus of a past age.

## STEAM PIPING FOR POWER PLANTS.

The *Street Railway Journal* contains a paper by Mr. Geo. H. Davis on steam piping, the duplication of which he looks on as necessary until steam piping is put up of a more permanent character than at present customary. At present there may be used one of eight systems according to the gravity of each case.

1. Single piping from one boiler to one engine, so that the stoppage of a boiler stops its own particular engine.
2. The same arrangement with the pipes in duplicate, whereby any accident to one steam pipe is provided for.
3. Same as No. 1, but a small main to connect the different units.
4. A large main divided into sections, and with branches to each boiler and engine.
5. A ring main circuiting boilers and engines, and divided into sections. The tendency of this is towards length and loss by condensation.
6. Two mains, large and small, with both large and small leads to engines and boilers.
7. The same as 6, but with two large mains and two equal leaders—a double system, one half to be used at one time.
8. The same, with two small mains and two small leaders all in use at once, except in case of accident.

With system 4, or any single system, reliability depends on excellence of work, and it is impossible to see the complication of valves and pipes on duplicate systems, without the thought arising that there should be some sufficiently reliable pipe to render it all unnecessary.

Mr. Davis says that a vigilant engineer to watch single piping will cost more in big wages than a cheaper man and interest on duplicate piping; but is there no other way in which a vigilant engineer can justify his cost.

In system 6, the small mains are idlers, to be used only when repairs are in progress of the large pipes, and then only with wire drawing for 15 or 20 per cent.

System 7 was the expensive method used with the first very large railway plants, and is denounced as having serious objections; but in No. 8, where both mains are small, and both are used, there are minimum heat losses and minimum first cost, and simply some drop of pressure if one pipe is temporarily called on to do all the work. Preferably the mains are laid below the boiler steam drums, and connected by the leaders and suitable six-radius bends. Then the two leaders are taken upwards again to the engine. The mains are thus to be easily placed in a basement alongside the engine foundation block. Steam enters and leaves the mains at their crowns. The mains serve as separators in this way, and special separators are dispensed with.

He sums up in favour of the small duplicate system. This system provides no excess area of pipe, and therefore its cost is a minimum for a duplicate system. The disabling of one pipe still leaves the other to do the work, and the increased friction may be met to some extent at least, by increasing the boiler pressure somewhat. Its area for cooling losses is 40 per cent. greater than the single system, but 30 per cent. less than the duplicate large pipes. As regards cost, it is estimated that while the cost of the single system may be set down as 100, the large duplicate system 180, while the small duplicate system costs but 110. The circle main comes in for but little praise, and we think rightly. Its cost is a maximum, 180, and we think it is a system liable to cause steam wetness. The small duplicate system was installed for the New Orleans Railroad, and the piping systems generally include:—(*a*) The high pressure steam pipes; (*b*) the condensing and exhaust system; (*c*) the feed water and purifying systems, including the artesian well system; (*d*) the drip and blow-off; (*e*) the fire protection pipes.

The engines are placed in a row parallel with the boilers. The duplicate mains spring from a Y-piece on each steam drum, and lead into the top of the two mains laid between the engines and boilers at a considerable height above the boilers, and provided with drain pipes. From each longitudinal main is taken off at its crown a pipe to the Y-piece at the separator of each engine. In full work each engine takes steam as directly as possible from the boilers opposite to it, and the longitudinal mains serve simply as equalisers between the different boilers. The pressure steam pipe is all wrought-iron, with wrought-iron bends to the boiler side of the main, and copper bends on the engine side. The joints are flanged, and the flanges are thickened at the threads, and the pipe ends opened into the flanges. Parallel with the longitudinal steam main are the injection and exhaust mains of the condensing apparatus, the feed main to the boilers, and the drip main and fire main. The idea on which the system is based appears to be to regard every main pipe as a distinct apparatus, quite apart from the engines and boilers. Each pipe has a certain duty to perform in receiving from one set of apparatus and passing forward to another. Whenever a new plant is to be installed, the system of piping required should first be thought out as carefully as the boilers or engines. This done, the engines require to be set out at such distance apart as will best suit standard lengths of pipe and connections. Designers who have this to do know well that there is a good deal of trouble involved in getting information to aid them. Thus makers of valves seem quite oblivious to the necessity of giving the over all length of their productions, apparently thinking that the crude method of making up lengths is quite sufficient, whereas it ought to be possible to place engines at exact distances apart, and arrange every pipe to suit this length.

The same remarks apply to far too many manufactured articles which ought all to be catalogued, with outline diagrams, showing the dimensions of every size by means of letters and tables. There is a good deal of talk about foreign competition just now, and it would be well if English makers would improve in the points we have noted. American and German makers of, frequently inferior, products, carry out a far better system of catalogues, and are therefore often able to get their productions specified simply because they have been easier to use in design.

## ELECTRIC AND MAGNETIC RESEARCH AT LOW TEMPERATURES.

By Professor J. A. FLEMING, M.A., D.Sc, F.R.S., *M.R.I.*, Royal Institution of Great Britain—Weekly Evening Meeting, Friday, June 5th, 1896.

The Right Hon. Lord Kelvin, D.C.L., LL.D., F.R.S., Vice-President, in the chair.

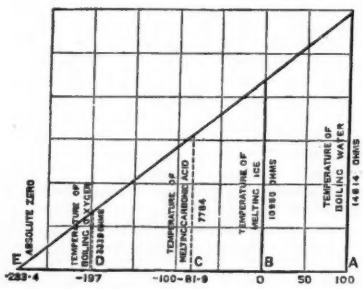
(*Continued from page* 201.)

A word or two must next be said on the manner in which we have represented graphically all the results of our experiments. We desired to delineate lines on a chart so as to express the change in specific resistance of all our metals and alloys in terms of temperature; and the question then arises, how was the temperature measured? You already know that an ordinary thermometer, whether mercury, alcohol, or air, would be useless to measure temperatures at which even air liquefies under ordinary pressures.

The employment of the constant pressure hydrogen thermometer with reduced pressure would have given us temperature readings very approximately those of the absolute thermo-dynamic scale, but the experimental difficulties of its use would have been enormous. We preferred to use the platinum resistance thermometer, and to express our temperatures in platinum degrees as follows:—Our experience has shown us that a pure soft annealed platinum wire may be cooled as often as necessary to the lowest attainable temperatures, and yet will always have the same resistance when measured again at other constant temperatures. Availing ourselves of this fact, we have used in all this work a low temperature platinum thermometer made in the following way:—a well annealed platinum wire is made into a resistance coil, as already described. Its resistance is carefully measured at the temperature of boiling water, 100° C., and melting ice, 0° C. From these measurements we construct a scale of temperature as follows:—A horizontal line, A E (see fig. 5), is taken on which to mark off temperature, and any two points, A and B, are taken on this line, and the length, A B, divided into 100 equal parts. At these points, B and A, perpendiculars are set up proportional to the resistance of the platinum wire at 0° C., and at 100° respectively, and through the tops of these perpendiculars a sloping straight line is drawn, until it cuts the axis of temperature at E. The graduation of the horizontal line is continued in both directions on the same scale as the subdivision of the line between the points marked 0 and 100. To measure and define any other temperature, say, for instance, the boiling point of liquid oxygen under a pressure of 760 mm., we have simply to measure the resistance of the platinum wire in the

liquid oxygen. We then look out on the chart the ordinate which has the same numerical value as the resistance of the wire in the oxygen, and at the foot of that ordinate we find a number, viz. (– 197), which is the temperature of the liquid oxygen on this platinum scale.

Two questions then arise: first, do all annealed platinum wires give, when used in this way, the same numerical values for definite and identical temperatures? The answer to this is nearly, but not quite. In the case of two thermometers much used by us, the difference was about half a degree at – 100° C., the boiling point of liquid ethylene. Into this matter it is not possible here to enter more fully; suffice it to say that we have invariably referred our temperature measurements to one standard thermometer. The second question is equally important: it is, What is the relation of the scale of temperature so defined to the absolute thermo-dynamic scale; or, which is very nearly the same thing, to the scale of temperature defined by a constant pressure hydrogen thermometer? If the air thermometer and platinum thermometer readings are made to agree




Method of constructing a scale of platinum temperature.

FIG. 5.

at 0° C. and 100° C., then a temperature which would be called 50° on the Centigrade scale would be denoted by 50·4° nearly on the platinum thermometer scale, and corresponding to – 78° on the Centigrade scale, which is the temperature of carbonic acid melting in ether. The platinum temperature by our standard is – 81·9°, and corresponding to – 182° C., which is very nearly the Centigrade temperature of liquid oxygen boiling at the normal pressure of 760 mm.; the platinum temperature by the same standard is – 197°. The conversion of these numbers representing low temperatures in platinum degrees into the numbers, representing the corresponding absolute thermo-dynamic temperatures, is a work we have reserved for a future research;* but meanwhile it may be said that there is no method of measuring low temperatures which is so easy of application, and so accurate, as that depending on the use of a platinum thermometer. All our work has been ultimately referred to one standard platinum thermometer, which we call $P_1$.

A suggestion may here be made. There is no reason why the Board of Trade electrical laboratory should not possess a standard platinum thermometer, defining officially platinum or absolute temperatures for all time, and with which other platinum thermometers could be easily and very accurately compared.

Having thus defined our scale of temperature, we proceeded to embody the whole of our results in a chart which is now before you (see fig. 6), and in which vertical distances represent resistivity, or specific resistance, or the resistance in absolute measure per cubic centimetre of the various metals, and horizontal distances represent platinum temperatures. The curves indicate the manner in which the resistivity varies with temperature for each substance.

The values of the resistivity of most ordinary metals and alloys are given in the table adjoining:—

ELECTRICAL RESISTIVITY OF PURE ANNEALED METALS.

| Metal. | Resistivity in C.G.S. units at 0° C. | Percentage increment, 0° to 100° C. | Atomic volume. |
|---|---|---|---|
| Silver ... ... ... | 1,468 | 40·0 | 10·04 |
| Copper ... ... ... | 1,561 | 42·8 | 7·10 |
| Gold ... ... ... | 2,197 | 37·7 | 10·04 |
| Aluminium ... ... | 2,665 | 43 5 | 10 56 |
| Magnesium ... ... | 4,355 | 38 1 | 13·76 |
| Zinc ... ... ... | 5,751 | 40·6 | 9·12 |
| Iron ... ... ... | 9,065 | 62·5 | 7·10 |
| Cadmium ... ... | 10,023 | 41·9 | 12·96 |
| Palladium ... ... | 10,219 | 35·4 | 9·12 |
| Platinum ... ... | 10,917 | 36·69 | 9·12 |
| Nickel ... ... ... | 12,323 | 62·2 | 6 94 |
| Tin ... ... ... | 13,048 | 44·0 | 16·20 |
| Thallium ... ... | 17,633 | 39·8 | 17·20 |
| Lead ... ... ... | 20,380 | 41·1 | 18 27 |
| Mercury ... ... | 94,070 | 38·88 | 14·56 |
| Bismuth ... ... | 108,000 | ... | 21·43 |

* Callendar has shown that over a wide range of temperature from 0° C. to 700° C. the difference between the platinum temperature and the air thermometer temperature is a parabolic function of the absolute temperature.

ELECTRICAL RESISTIVITY OF ALLOYS.

| Alloy. | Composition. | Resistivity in C.G.S. units at 0° C. | Percentage increment 0° C. to 100° C. |
|---|---|---|---|
| Aluminium-copper ... ... | 94 : 6 | 2,904 | 38 1 |
| Aluminium-titanium ... | ... | 3,887 | 29·0 |
| Aluminium-silver ... ... | 94 : 6 | 4,641 | 23 8 |
| Gold-silver ... ... ... | 90 : 10 | 6,280 | 12·4 |
| Copper-aluminium ... ... | 97 : 3 | 8,847 | 8·97 |
| Copper-nickel aluminium ... | 87 : 6½ : 6½ | 14,912 | 6·45 |
| Platinum-rhodium ... ... | 90 : 10 | 21,142 | 14·3 |
| Nickel-iron ... ... ... | 95 : 5 | 29,452 | 20 1 |
| German silver ... ... | $= Cu_5\ Zn_3\ Ni_2$ | 29,982 | 2·73 |
| Platinum-iridium ... ... | $= Pt_4\ Ir$ | 30,896 | 8·22 |
| Platinum-silver ... ... | $1 : 2 = Pt\ Ag_4$ | 31,582 | 2·43 |
| Platinoid ... ... ... | ... | 41,731 | 3·1 |
| Manganin ... ... ... | ... | 46,678 | 0· |
| Iron-manganese ... ... | 83 : 12 | 67,148 | 12·7 |

The first thing which strikes us on looking at the chart (fig. 6) is that the lines for the pure metals all converge downwards, in such a manner as to indicate that their electrical resistance would vanish at the absolute zero of temperature, but that no such convergence is indicated in the case of alloys. We have found that the slightest impurity in a metal changes the position of the resistance line. In the next place, note that the order of conductivity is different at low temperatures to that at ordinary temperatures. At 13° C. pure silver is the best conductor; but at – 200° pure copper is better than silver, and the position of mercury is, of course, very different.

Again, the lines of some metals are very much curved. The principal magnetic metals, iron and nickel, have lines which are very concave upwards, and this is a characteristic apparently of many magnetic alloys. The mean temperature coefficient of these magnetic metals between 0° C. and 100° C. is much larger than that of other metals, and the percentage decrease in resistance in cooling them from + 200° C. to – 200° C. is greater than in the case of any other metal. It is worth noting in passing that these magnetic metals, iron and nickel, have smaller atomic volumes than any other metal, and that, generally speaking, the worst conductors amongst the metals are those that have the large atomic values and large valency.

Next turning to alloys, we may make mention of a few general facts with regard to their resistance. If to one pure metal we add a small quantity of any other metal, the result is always to raise the resistance line almost parallel to that of the predominant constituent. Thus, in our own chart, the alloy consisting of 6 per cent. of copper, with 94 per cent. of aluminium, is parallel to the aluminium line, but higher up. Three per cent. of aluminium, added to 97 per cent. of copper, yields an alloy with a resistance line parallel to that of copper, also higher up. When two pure metals are alloyed together in various proportions, there is generally some proportion in which the resultant alloy has a maximum resistivity, and except in the case of alloys of zinc, tin, lead and cadmium with each other, the resistivity of the alloy is greater than that of either of its constituent metals. In the case of many well-known alloys, the proportions which give high, if not the highest resistivity, are those which correspond to definite and possible chemical combinations of the metals with each other, as, for instance, in the well-known platinum-silver alloy in proportion 33 to 66, which corresponds in proportion with the combination, $Pt\ Ag_4$; the iron-nickel alloy in proportion of 80 to 20, which corresponds with the combination, $Ni\ Fe_4$; the platinum-iridium alloy 80 to 20, which corresponds with the combination, $Ir\ Pt_4$, and the copper-manganese alloy 70 to 30, which corresponds with the compound $Cu_2\ Mn$, all of which are, as far as valency is concerned, possible compounds. It is, however, found that very high resistivity generally involves in alloys a want of tenacity and ductility, and when we reach such limits as 100 microhms per cubic centimetre, we begin to find the solid alloys becoming less useful, on account of this deterioration of their useful mechanical quality.

We have especially studied the electrical resistance, at low temperatures, of a large series of steel alloys, containing varying proportions of nickel, aluminium, chromium, tungsten and manganese in them.

We have found that the electrical effect of adding to the iron the other elements of the alloy is usually to shift up the resistance line nearly parallel to itself, so that the resistance lines of all the iron alloys are nearly parallel to that of the iron line, only the absolute value of all the ordinates is increased. This is equivalent to saying that the effect of the added material is to increase the specific resistance, but not to alter the slope or form of the resistance curve. Amongst these steel alloys there are two or three that are very interesting. A nickel-steel alloy, containing 19 per cent. of nickel, sent to us by Mr. R. A. Hadfield, exhibits some very extraordinary properties. Nickel-steel alloys, with large percentages of nickel, can, as Dr. Hopkinson has shown,* exist over wide limits of temperature in two different physical states, in one of which they are strongly magnetic, and in the other of which they are feebly magnetic, and they pass from the non-magnetic to the magnetic, on cooling, to low temperatures. Here, for instance, is a sample of the 19 per cent. nickel steel in the non-magnetic condition. If it is cooled in liquid air, we can make it pass instantly into a magnetic condition. In the first state it is fairly ductile and plastic, but in the second state it is very hard and brittle. Moreover, its electrical resistance and thermo-electric power are both permanently altered on undergoing this change. In the non-magnetic state it has a high resistivity of about

* See *Proc.* Roy. Soc., 1890, Vol. xlvii., p. 138.

81,500 C.G.S. units per cubic centimetre at 0° C., but on cooling in liquid air and becoming magnetic, it is found to have decreased to about 47,200 C.G.S. units when taken at 0° C. A very pretty way of showing this difference in resistivity is to dip one half of a wire of the 19 per cent. nickel-steel in liquid air, and then take it out, and pass a strong electric current through the wire. The current raises the half which has not been dipped into liquid air to a red heat before the other half is visibly red hot.

It is, perhaps, more correct to say that this alloy can exist in an infinity of different physical states, because we have found that the lower it is cooled in temperature the lower its resistivity can be made

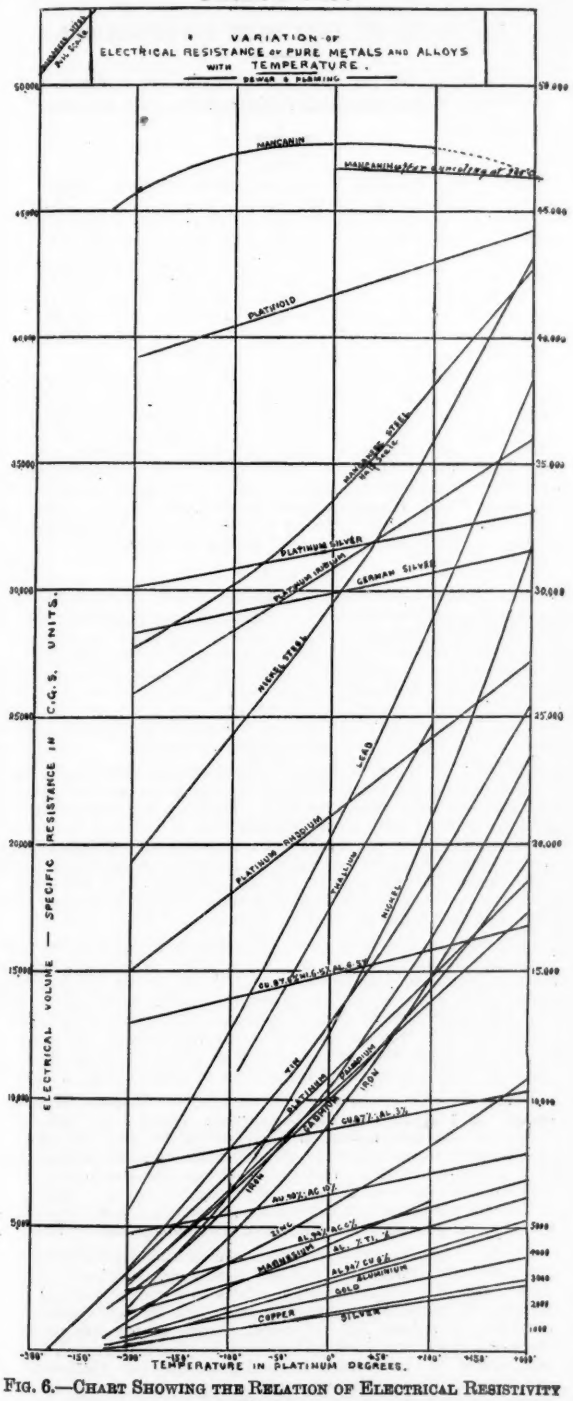



Fig. 6.—Chart Showing the Relation of Electrical Resistivity and Temperatcre.

to be when measured again at ordinary temperatures. On heating up the alloy again to a bright red heat it goes back into the non-magnetic ductile state.

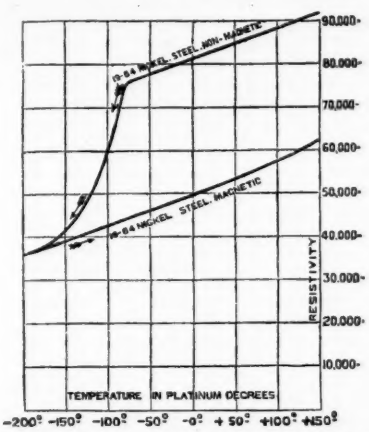
The chart (fig. 7) before you shows the manner in which the electrical resistance varies between the limits of −200° C. and 150° C. when the alloy is taken through a cycle of temperature beginning at 150° C. in its non-magnetic state.

The 29 per cent. nickel-steel exhibits the same characteristics in a less marked degree. A close study of this interesting material shows that there is room for much valuable work upon it yet.

A manganese-steel, brought to notice by Mr. R. A. Hadfield, having about 12 per cent. of manganese in it, is also capable of existing in two states, a magnetic and a practically non-magnetic variety. The magnetic variety, which is much more brittle, is, however, in this case formed by the prolonged slow heating of the non-magnetic variety out of contact with air. In the non-magnetic condition the material has a rather high specific resistance at 0° C., about 65,700 C.G.S. units per cubic centimetre; but the magnetic variety has a much lower specific resistance, viz., about 51,400 C.G.S. units at 0° C.

In all these cases it is interesting to note that the change of the alloy into the magnetic variety is accompanied by a decrease in resistivity or increase in conductivity, and an increase in brittleness.

We have tried cooling this non-magnetic variety of manganese-steel in liquid air, but have not been able in that way to make any change in its condition as regards magnetic susceptibility.


19·64 NICKEL STEEL NON-MAGNETIC
19·64 NICKEL STEEL MAGNETIC
RESISTIVITY
TEMPERATURE IN PLATINUM DEGREES
−200° −150° −100° −50° −0° + 50° +100° +150°

Curve showing the variation of resistivity of nickel-steel (19·64 per cent. nickel) when taken through a cycle of temperature from + 150° to − 200° and back again.

Fig. 7.

There is a particular alloy, of copper 84 per cent., manganese 12 per cent., and nickel 4 per cent., called manganin, which, at ordinary temperature, exhibits but little change of resistance with change of temperature. On taking the curve of its resistance over wide ranges of temperature, we find that its curve is very concave downwards, and the vertex of the curve lies at about 16° C. Hence at ordinary temperatures small changes of temperature make no change in its resistance; but above that point its temperature coefficient is negative, and below it it is positive. All alloys in which a negative temperature coefficient has been observed are probably instances of the same mode of variation of resistance. It may be noted in passing that the element manganese, when present in an alloy, seems to have a great tendency to produce high resistivity and small temperature coefficient.

Returning, then, to the pure metals, we may ask, What is the meaning of the fact that in their case the resistance lines all converge so as to indicate that the electrical resistance would vanish at the absolute zero of temperature?

We know that the passage, as we call it, of an electric current through a conductor heats it, and that by Joule's law the rate of production of heat in the conductor is proportional to the square of the current strength and to the total resistance of the conductor.

Suppose we take two wires, say, of iron and a certain copper-nickel-aluminium alloy having the same resistivity at 100° C. and of the same size and length. These wires will at + 100° C. have the same resistance. A given current flowing through them will therefore generate heat in them both at the same rate.

Cool them both down, however, to the temperature of liquid air. In the case of iron wire the resistance is reduced to one-fifteenth of its value at − 200° C., in the other case it is reduced by only 10 per cent. Hence, at the low temperature, the alloy dissipates energy for the same current 10½ times as rapidly as the pure metal.

*(To be continued.)*

## ELECTRICAL NEWS FROM AUSTRALIA

[FROM OUR SPECIAL CORRESPONDENT AT SYDNEY.]

At present Tasmania seems to be quite taking the lead in electrical matters, the Launceston central station having shown very good results, over 3,000 lamps having been installed since February in business premises and private houses. Messrs. Siemens Bros. have secured a contract for the equipment of a tramway joining the Tasmanian Gold Mining Company's (Beaconsfield, Tasmania) mine to the lower battery and chlorination works, the tramway being for the purpose of hauling ore. The lighting of the mine and mine buildings is also included in the contract. Notice has been gazetted of the intention of a party of Hobart and Zeehan gentlemen to apply to Parliament for power to take over the rights conferred on Mr. McLean, of using water from McLean's Creek, near Zeehan, for the generation of electricity, to be used for light and power purposes in the town and mining district of Zeehan. The usual borrowing powers and regulations are included in the application. Mr. A. C.

Parker, the manager of the Hobart Electric Tramways, had a narrow escape a short time ago. While driving in a buggy the horse bolted, and eventually colliding with a dray, threw Mr. Parker several feet in the air. Fortunately, however, he escaped with severe bruises, no limbs being broken.

Arrangements have just been completed whereby Karori—a suburb four miles out of Wellington (N.Z.)—is to be connected with the city by an electric tramway service, about to be carried out by a local syndicate. At one point, Baker's Hill, the line is to go through a tunnel, at which point the road is to be lowered some 12 feet. The work is to be started not later than April 1st, 1897, under an agreement on the "betterment" system, by which the owners of property at Karori, to the value of £40,000, bind themselves to pay the syndicate 25 per cent. of the increased value of their land, in the event of any sale for the next 10 years. The present value to be arrived at by taking the valuation for land tax purposes plus 10 per cent. The same syndicate is making overtures for the acquisition of the existing Wellington City Tramway with a view to the use of electricity instead of horses as the motive power.

In Victoria, the Geelong Electric Supply Syndidate is petitioning the Governor-in-Council (under the recently passed General Electric Lighting Act) for power to supply electricity for public and private purposes throughout Geelong and its suburbs. It is promised in the application that the erection of works and lines shall be commenced within 18 months from the granting of the order. It is not long since the Geelong Municipal Council thrashed out the question of a municipal central electric light station, the matter being finally shelved after a protracted struggle. The Councils of Fitzroy and Collingwood, suburbs of Melbourne, have also been considering the question of lighting some of the main streets, but the question was negatived on account of a want of funds.

The streets in the town of Coolgardie are now lit by electric light, which is reported to be a great success.

In New South Wales interest is centered on the Sydney Municipal Council's Electric Lighting Bill, which it is confidently expected will be passed this Session of Parliament, it having already passed the second reading. *Apropos* of electric lighting Acts, Mr. J. O. Callender read a very interesting paper before the Electric Club of New South Wales at their last meeting on "Electric Light Legislation," in the course of which he drew attention to a clause in the Water and Sewerage Municipal Act, which provided that the repayment of money lent by the Government for this purpose should be a first charge on all rates levied for any purpose whatsoever. Mr. Callender pointed out that this would refer also to lighting rates, and might seriously interfere with the introduction of municipal electric lighting.

## NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. Thompson & Co. *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

### NEW PATENTS.—1896.

17,161. "The manufacture of an improved active material for the plates or electrodes of electric accumulators." S. Hammacher. Dated August 4th.

17,180. "Improvements in combined typewriters and electro-telegraphic transmitters." W. L. Wise. (World Flash Company, U.S.A.) Dated August 4th. (*Complete.*)

17,187. "An improved electric cable or conductor for electric fire or other alarm systems." C. D. Tisdale and J. D. Gould. Dated August 4th. (*Complete.*)

17,200. "Improvements in and in connection with supports for electric lamps." W. L. Wise. (F. E. Kinsman, U.S.A.) Dated August 4th.

17,203. "Improvements in methods and means for electric regulation of power." H. B. Gale and C. T. Thompson. Dated August 4th. (*Complete.*)

17,222. "Improvements in portable telephones." C. De Ricaris. Dated August 4th.

17,257. "Improvements in electric meters." E Batault. Dated August 5th.

17,338. "Improved device for automatically throwing into circuit reserve electric lamps, motors, or resistances in case of breakdown, and for protective purposes." E. Jokl, W. M. Christian, and G. Kemp. Dated August 5th.

17,346. "Improvements in or connected with secondary or storage batteries." F. F. E. Heyse and W. H. Akester. Dated August 6th.

17,363. "Improvements in electromotors." R. Kennedy. Dated August 6th.

17,389. "Improvements in electric rock drills, caulking tools, and other reciprocating machines." A. T. Snell. Dated August 6th.

17,395. "Improvements in magnetic cut-outs." L. Andrews. Dated August 6th.

17,557. "Improvements in continuous current dynamo-electric generators and motors." S. Z. De Ferranti. Dated August 8th.

17,558. "Improvements in dynamo-electric generators and motors." S. Z. De Ferranti. Dated August 8th.

17,577. "Improvements in electrical measuring instruments." G. K. B. Elphinstone. Dated August 8th.

17,578. "Improvements in electrical signalling apparatus." G. K. B. Elphinstone. Dated August 8th.

17,579. "Improvements in electric railway systems." D. MacLauchlin. Dated August 8th. Date applied for under Patents, &c., Act, 1883, Sec. 103, January 9th, 1896, being date of application in United States.

17,608. "Improvements in means or apparatus for effecting the electro-deposition of zinc or other metals upon tubes or other circular or analagous objects." The Cowper-Coles Galvanising Syndicate, Limited, and S. O. Cowper-Coles. Dated August 8th.

### ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d. (in stamps.)*]

#### 1895.

8,994. "Improvements in and connected with arc lamps." W. Jandus. Dated May 6th, 1895. Relates to a lamp of the kind in which the arc is surrounded by a second inner globe which permits gases due to combustion to flow out, fresh air being prevented from entering. Covers various details of construction, the principal being the use of a particular form of annular electro-magnet surrounding the upper carbon or carbon holder, and adapted to act to raise the carbon or holder by means of a series of vertical clutch rings contained in slots in the bottom of the magnet core. These rings have roughened edges to prevent slipping. 4 claims.

13,636. "Improvements in electric signalling and similar apparatus." L. S. Crandall. Dated July 16th, 1895. Comprises a framework having a sufficient number of lamps to form any letter or monogram is provided, and a multiple switching device by means of which those lamps only are lighted which form the letter or monogram desired. The lamps are arranged in sets or elements for convenience in operation. The switch is made so that on pressing a particular key the lamps, or sets of lamps, will be lit which produce the character on the key, so that by pressing a given combination of keys in succession words may be spelled out if desired. 3 claims.

#### 1896.

9,853. "Improvements in and connected with electric belts, and like appliances to be worn next the skin." G. S. Collicott. Dated May 8th, 1896. Relates to an electric body belt or like appliance to be worn next the skin, and having two or more reticulated plates of aluminium or other metal which does not injuriously affect the skin. These plates are connected by wires to the two plates of a pocket electric battery so that by making contact a current is sent through the wires, being distributed through the part of the body with which the reticulated plates are in contact. 1 claim.

10,608. "An improvement in tumler electric switches." The Edison and Swan United Electric Light Company, Ltd., and C. F. Proctor. Dated May 16th, 1896. Relates to the construction of a tumler electric switch which consists of a roller of insulating material mounted on the handle and a contact lever and stamped out of sheet metal with one end fixed to the base, the other end being split. When the handle is moved the roller depresses the contact lever, causing its split end to become wedged between the two contacts, thus completing the circuit. 1 claim.

11,162. "Electric time alarm apparatus." F. W. Golby. (H. Winter, Bohemia.) Dated May 22nd, 1896. Relates to electric alarm apparatus for any desired number of alarms distinguished by a metallic ring fixed on a clock case and insulated from the same. On this is arranged a movable clasp furnished with a projection in such a manner that at the desired moment by means of the hour hand coming in contact with the projection an electrical circuit is completed through a battery, and through one or more alarms. 1 claim.

13,074. "Improvements in the manufacture of electrical resistances." A. J. Marquand and D. Lowdon. Dated June 13th, 1896. Relates to the manufacture of electrical resistances to be used as regulators which can be varied at will, which consists of impregnating a non-conducting material such as asbestos cloth with carbonaceous matter and exposing it to heat. This carbonised cloth is then cut into the desired shape and arranged in a pile and appliances by which the pile can be submitted to a graduated pressure. 3 claims.

13,079. "Improvements in and connected with dry batteries and the like." W. Thompson. (C. C. Lesenberg, Germany.) Dated June 13th, 1896. This invention relates to a special peculiar construction of gas vent or exhausting valve with air tight construction consisting of a small tube of metal, ebonite or the like provided along the upper part with an external longitudinal groove, lateral perforations, or equivalent means and projecting into the interior of the battery. An elastic India-rubber cap is fixed firmly over the upper external end of said tube without, however, filling up the longitudinal groove by covering over said groove or lateral perforations. The invention relates also to a connecting wire or terminal formed of an elastic spiral wire, and soldered to the positive electrode end by a whole turn of coil of the spiral. 2 claims.

13,521. "Improvements in the manufacture of carbon anodes for electrolytical processes." P. Jensen. (H. Cappelen and D. Cappelen, Norway.) Dated June 18th, 1896. Relates to the manufacture of carbon anodes for electrolytical processes, and consists in impregnating the pores of natural or artificial carbon with an electrically and chemically inert material such as paraffin and other fluid fatty matters which prevents the entry of the liquid and thus also the noxious influence of the current upon the carbon. 2 claims.